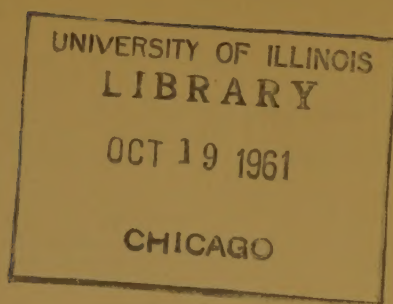
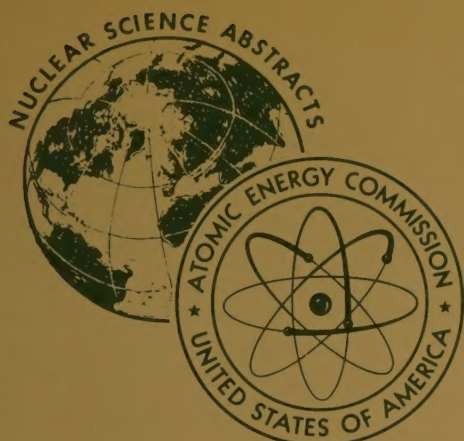


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NUCLEAR SCIENCE ABSTRACTS

Volume 15 Number 17

Abstracts 21906 - 23161

September 15, 1961

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TABLE OF CONTENTS

Volume 15, Number 17, September 15, 1961

| <i>Category</i> | <i>Page</i> | <i>Category</i> | <i>Page</i> |
|------------------------------------|-------------|----------------------------------|-------------|
| GENERAL AND MISCELLANEOUS . . . | 2821 | METALS, CERAMICS, AND OTHER | |
| BIOLOGY AND MEDICINE . . . | 2824 | MATERIALS . . . | 2916 |
| General and Miscellaneous . . . | 2824 | General and Miscellaneous . . . | 2916 |
| Biochemistry, Nutrition, and | | Corrosion . . . | 2917 |
| Toxicology . . . | 2828 | Fabrication . . . | 2919 |
| Fallout and Ecology . . . | 2832 | Properties and Structure . . . | 2922 |
| Radiation Effects on Living | | Radiation Effects . . . | 2936 |
| Tissues . . . | 2833 | PHYSICS . . . | 2940 |
| Radiation Sickness . . . | 2857 | General and Miscellaneous . . . | 2940 |
| CHEMISTRY . . . | 2860 | Astrophysics and Cosmology . . . | 2948 |
| General and Miscellaneous . . . | 2860 | Cosmic Radiation . . . | 2949 |
| Analytical Procedures . . . | 2866 | Criticality Studies . . . | 2950 |
| General Inorganic and Physical | | Elementary Particles and | |
| Chemistry . . . | 2871 | Radiations . . . | 2950 |
| Radiation Chemistry and | | Neutron Physics . . . | 2953 |
| Radiochemistry . . . | 2875 | Nuclear Properties and | |
| Raw Materials and Feed | | Reactions . . . | 2954 |
| Materials . . . | 2880 | Particle Accelerators . . . | 2960 |
| Separation Processes . . . | 2881 | Plasma Physics and Thermonuclear | |
| ENGINEERING AND EQUIPMENT . . . | 2885 | Processes . . . | 2962 |
| General and Miscellaneous . . . | 2885 | Shielding . . . | 2968 |
| Heat Transfer and Fluid Flow . . . | 2888 | Theoretical Physics . . . | 2969 |
| Instrumentation . . . | 2891 | REACTOR TECHNOLOGY . . . | 2971 |
| Materials Testing . . . | 2898 | General and Miscellaneous . . . | 2971 |
| GEOLOGY, MINERALOGY, AND | | Power Reactors . . . | 2976 |
| METEOROLOGY . . . | 2899 | Production Reactors . . . | 2981 |
| HEALTH AND SAFETY . . . | 2904 | Research Reactors . . . | 2981 |
| INDUSTRIAL APPLICATIONS OF | | WASTE DISPOSAL AND | |
| ISOTOPES AND RADIATIONS . . . | 2910 | PROCESSING . . . | 2983 |
| ISOTOPE SEPARATION . . . | 2912 | CORPORATE AUTHOR INDEX . . . | INDEX-1 |
| MATHEMATICS AND COMPUTERS . . . | 2914 | PERSONAL AUTHOR INDEX . . . | INDEX-8 |
| | | REPORT NUMBER INDEX . . . | INDEX-41 |
| | | SUBJECT INDEX . . . | INDEX-49 |



NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

21906 (AERE-Bib-134) LIST OF UNCLASSIFIED DOCUMENTS PUBLISHED BY STAFF OF THE CHEMISTRY DIVISION DURING 1960. B. C. L. Salman, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1961. 22p.

21907 (AFOSR-461) AN ELECTROMAGNETIC ROCKET SYSTEM OF HIGH SPECIFIC THRUST. Research Report 103. R. J. Rosa (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Apr. 1958. Contract AF49(638)-61. 10p.

A nuclear-electric propulsion system is described which avoids the necessity for a low-temperature heat sink. The system is an open thermodynamic cycle which in effect re-uses the working fluid several times without recirculating it. Although a very large specific impulse cannot be produced, it does seem possible to get a substantial improvement in the impulse obtainable for a given nuclear pile temperature. In addition, the elimination of the heat sink increases the possibility of making nuclear-electric systems having a high thrust to weight ratio and an ability to function within the atmosphere. (auth)

21908 (AFSWC-TR-60-68(Vol.II)) THE DESIGN OF A LABORATORY EXPERIMENT TO STUDY THE EARLY HISTORY OF A NUCLEAR EXPLOSION ABOVE THE EARTH'S ATMOSPHERE BUT WITHIN THE EARTH'S MAGNETIC FIELD. A. Duneer (Republic Aviation Corp. Missile Systems Div., Mineola, N. Y.). Dec. 16, 1960. Contract AF 29(601)-2325. 87p.

Information is presented on the following topics: thermalization of counterstreaming plasmas; electric probe experiments; the use of magnetic probes to measure the field in a magnetic piston; the calibration of a magnetic probe; and liquid-metal instability experiments. (B.O.G.)

21909 (ARGMA-TN2H1N-28) RESEARCH LABORATORY QUARTERLY RESEARCH REVIEW NO. 28, NOVEMBER 1, 1960-JANUARY 31, 1961. (Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala.). Mar. 1, 1961. 97p.

The supporting research activities of the Research Laboratory, Research and Development Operations, during the period November 1, 1960 through January 31, 1960, are described. Subjects covered include materials, nuclear physics, fuels and combustion, physical electronics, high-temperature physics, and solid-state physics. (auth)

21910 (BNL-632) ANNUAL REPORT, JULY 1, 1960. (Brookhaven National Lab., Upton, N. Y.). 196p.

Research facilities, general construction progress, re-

search activities, and administration are discussed and a financial statement is given. Fairly detailed accounts are given of research programs in the fields of physics, accelerator development, instrumentation, applied mathematics, chemistry, nuclear engineering, biology, and medicine. (M.C.G.)

21911 (CF-61-5-90) THE LABORATORY DIRECTOR'S REVIEW COMMITTEES AT ORNL. Francois Kertesz (Oak Ridge National Lab., Tenn.). May 10, 1961. 17p.

The basic reasons for establishing the Laboratory Director's Review Committees are discussed together with a short description of the field of activity of each committee. (auth)

21912 (DPR/INF/259) NUCLEAR POWER POLICY IN THE UNITED KINGDOM. Roger Makins (United Kingdom Atomic Energy Authority, London). Mar. 1961. 7p.

The United Kingdom nuclear power program announced in 1955 and designed to introduce between 1500 and 2000 megawatts of nuclear electricity by 1965 is reviewed. Changes in the original program, the role of industry, factors affecting the development of the program, the validity of the assumptions on which the estimates were based, policy considerations, further developments, and the problem of marine nuclear propulsion are discussed. (M.C.G.)

21913 (JPL-TR-32-115) THE CONCEPTUAL DESIGN OF A NUCLEAR ELECTRIC POWER SPACECRAFT FOR THE EXPLORATION OF JUPITER. Robert J. Beale (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). May 24, 1961. Contract NASw-6. 24p.

A description is given of the conceptual design of a Jupiter capture spacecraft which utilizes the electrical power output of 1.3 Mw from a nuclear power source to drive an ion engine. Starting with a gross spacecraft weight of 45,000 lb in a 300 nautical mi earth orbit, the tradeoff between terminal mass at Jupiter and flight time to Jupiter utilizing the electric propulsion system is shown. A typical flight trajectory to the target planet is illustrated. The considerations of the various subsystem requirements and constraints are reviewed and the resulting configuration is shown. A summary of typical system weights and power requirements is listed, and a sequence of operations is described beginning with reactor startup in the earth orbit, following through to the power switch over from the thrust unit, to the scientific experiments upon arrival at the target planet. Possible scientific experiments at Jupiter are listed and related to the unique characteristics of a nuclear electrical spacecraft. As an example, the high power level available at the completion of

the thrust period is utilized to operate a high-powered wide bandwidth transmitter which will allow for transmission of high-quality video pictures back to Earth. (auth)

21914 (NAS-NRC-Pub-895) **RADIOACTIVE CONTAMINATION OF MATERIALS USED IN SCIENTIFIC RESEARCH.** James R. DeVoe (National Research Council. Committee on Nuclear Science). 1961. 149p.

Nuclear Science Series Report No. 34.

A study was made of radioactive contamination in materials. An attempt was made to relate the radioactive contamination of a substance to its use in a low-background detector. Information was collected on the mechanisms by which radioactivity enters reagents and materials. The chemical reagents, metals, and other materials and the radioisotopes contaminating each of them are discussed. Industrial uses of radioisotopes which can cause low-level contamination problems are described. The radioactive contamination of most materials and reagents appeared to be due to naturally-occurring radioisotopes. Those elements which are susceptible to radioisotopic contamination are listed. Stockpiling, cooperation with the manufacturer, utilizing substitute materials, and procuring the substance from special sources are discussed as possible methods for obtaining uncontaminated substances. Appendices include data on radioactivity in reagent chemicals and materials; analyses of background in phototubes, sodium iodide cups, and gamma counters; a list of naturally-occurring radioisotopes; concentrations and production rates of cosmic-ray produced radioactivities; a list of long-lived isotopes; work on low-activity glasses for use in whole-body counters; and the principles of construction of low-background detectors. (M.C.G.)

21915 (NP-10312) **PIONEERING RESEARCH, ANNUAL REPORT, 1960.** A Report for 1960 on the Research Activities of the Pioneering Research Division. (Quartermaster Research and Engineering Command, Natick, Mass.). 86p.

Abstracts are presented of 73 phases of basic research carried out in biology, chemistry, and physics. (B.O.G.)

21916 (NP-10313) **SPACE PROGRAMS SUMMARY NO. 37-8, VOLUME I, JANUARY 15, 1961-MARCH 1, 1961.** (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 1, 1961. Contract NASw-6. 43p.

Lunar Program. The tests to be run on the Ranger proof test model and RA-1 are described. Instrumentation of these space vehicles for telecommunication, secondary power, and environmental testing is discussed. The status of the Surveyor and Prospector projects is outlined.

Planetary-Interplanetary Program. The status and instrumentation of the Mariner project are discussed in some detail. Deep Space Instrumentation Facility. The operation and instrumentation of the Goldstone, Calif.; Woomera, Australia; and Johannesburg, South Africa, tracking stations are discussed. (D.L.C.)

21917 (NP-10336) **RAPPORT ANNUEL 1960.** (Annual Report, 1960). (Institut Interuniversitaire des Sciences Nucléaires, Brussels). 271p.

A report is made of the activities of l'Institut Interuniversitaire des Sciences Nucléaires for 1960. The report includes information on organization and personnel, facilities, conferences held, publications, nuclear science courses at Belgian universities, and collaboration with the CEN. Abstracts of technical publications in nuclear physics, chemistry, and radiobiology and therapy are also included. (T.R.H.)

21918 (NP-10344) **BLAST LOADING OF 8-FOOT ALUMINUM BEAMS.** Technical Report R-148. Type C

Final Report. S. K. Takahashi and D. F. Green (Naval Civil Engineering Lab., Port Hueneme, Calif.). June 9, 1961. 43p.

Sixteen built-up beams fabricated from 5456-H311 and 5456-H32 aluminum alloy were tested under uniformly distributed static and blast loads. The beams had a clear span length of 8 feet 1 and $\frac{5}{16}$ inches and an end fixity of 85%. Three beams were loaded statically to failure. The remaining beams were subjected to blast loads of smaller magnitude to determine the dynamic response. Buckling occurred after yielding in the lower flange and web adjacent to the supports at static and dynamic loads of 130 and 63 pounds per inch, respectively. Based on a yield load with a factor of safety of 1.65, design static and dynamic working loads of 64 and 29 pounds per inch, respectively, are recommended for the specific beams tested. A chart is included which may be used to predict the maximum deflection of a structural member in the plastic range under a long-duration load once the static properties are known. (auth)

21919 (RM-2490-1(RAND)) **THERMOELECTRIC POWERPLANTS UTILIZING CONTAINED NUCLEAR EXPLOSIONS.** G. A. Hoffman (RAND Corp., Santa Monica, Calif.). Feb. 18, 1960. Contract AF 49(638)-700. 39p.

The problem of stationary thermoelectric powerplants that would utilize the thermal energy released by detonating nuclear devices in a closed cavity, surrounded by a heat exchanger, is defined. The major obstacles to the realization of such a system are: the excavation of large, up to 1500 ft in diameter, cavities in rock and their preservation under lithostatic and explosive pressures; the definition of the shock phenomena from the detonation and the response and survival of the cavity and heat exchanger under the reflected shocks up to 3000 psi for very short durations; and the over-all economic feasibility of the system, which may require a capital investment of 2 billion dollars but might produce electric power at a cost competitive with that of conventionally produced power. The evaluation of these problems is prompted by the advantages of such a hypothetical system: the use of transient fusion pulses, with the energy being absorbed by a heated gaseous mass and slowly released to turboelectric generators, seems an early, though unrefined, solution to the problem of exploiting fusion energy, and is far less complicated than the requirements for using a sustained fusion process. The results suggest that none of the obstacles are insurmountable. (auth)

21920 (SC-4614(RR)) **HIGH EXPLOSIVE CRATER STUDIES: DESERT ALLUVIUM.** Byron F. Murphey (Sandia Corp., Albuquerque, N. Mex.). May 1961. 44p.

Crater dimensions were determined for 23 explosions of 256-pound spherical TNT charges buried in desert alluvium. As opposed to previous work covering depths of burst as great as 6 feet, the work presented in this report extends knowledge of apparent crater radius and depth to depths of burst as great as 30 feet. Optimum depth of burst for apparent crater radius was near 10 feet and for apparent crater depth near 8 feet. Surface motion photography illustrated a very great slowing down of the surface motion between depths of burst of 9.5 and 15.9 feet. Crater contours, profiles, and overhead photographs are presented as illustrations. (auth)

21921 (TID-3705) **INFORMAL LISTING OF BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE.** Bibliographies Issued or in Progress During the Period April-May 1961. (Office of Technical Information Extension, AEC). 35p.

The listing includes issued bibliographies numbering

100, and those in preparation numbering 101. Subject and author indexes are included. (J.R.D.)

21922 (NP-tr-637) NEW DEVELOPMENTS IN MILITARY EQUIPMENT (SELECTED ARTICLES). Translated from p.27-33; 161-214; 372-80 of "Novoye v Voennoy Tekhnike" (A publication of the Military Publishing House of the Defense Ministry of USSR, Moscow, 1958). 89p.

Selected articles on new developments in military equipment are presented. Topics covered include: guided missiles as carriers of nuclear warheads, the development of naval materiel, military shipbuilding, ship-based artillery, mine and torpedo weapons, landing means, rocket weapons, and combat operations at sea, guidance method of the ship-borne missile "Terrier," ship gas turbine, and techniques of underwater detection. (M.C.G.)

21923 THE STATISTICAL ASSESSMENT OF RADIOACTIVE ISOTOPES AND THEIR EVALUATION. H.-J. Marcinowski (Isotopen-Studiengesellschaft e. V., Frankfurt am Main). Atomwirtschaft, 6: 293-5(May 1961). (In German)

In the statistics of radioactive substances, important problems emerge since the application of radionuclides in most fields extends over a large number of isotopes with a wide range of activities. The development of the application of radioactive materials can be critically assessed only by a sensible breakdown into methods of production and groups of application. (auth)

21924 ATOMS FOR INDUSTRY WORLD SURVEY. Gerald Wendt, ed. New York, Atomic Industrial Forum, Inc., 1960. 160p.

The industrial aspects of atomic energy are discussed, and programs and prospects in various countries are outlined. Economic, safety, legal control, and public interest aspects are reviewed. Reactors, especially power reactors, are discussed. The fuel cycles of natural and enriched U, Pu, and Th fuels, including mining, research, and reprocessing, are examined. Marine propulsion uses for atomic energy are noted. Industrial programs of the atomic energy branches of several governments are reported. Applications of various isotopes and radiation are studied. (T.F.H.)

BIOLOGY AND MEDICINE

General and Miscellaneous

21925 (AD-248855) THE EFFECT OF ANIMAL MATURITY AND FAT DISTRIBUTION ON THE QUALITY OF IRRADIATED BEEF. Report No. 7 (Final), September 6, 1957–June 30, 1960. R. L. Henrickson (Oklahoma State Univ., Stillwater). Contract DA19-129-QM-1033. 98p.

The effects of animal maturity and fat distribution on the quality of irradiated beef were investigated. For ground beef the preference ratings decreased as the irradiation dose increased. When the meat was stored at 40°F, those samples treated with low doses of irradiation quickly decreased in preference. Meat treated with 0.5 megarad of gamma radiation had little irradiation flavor change. Ground meat from animals slaughtered at 12 months of age was generally preferred, followed by products from 24 and 6 month old animals. Altering the fat content of the ground meat caused some change in eating preference of the irradiated product during storage. Meat of low fat content from animals slaughtered at 12 months of age was generally preferred. For steak, shear and taste panel values indicated that some tenderness variation does exist among animals. Flavor and texture difference also occurred among beef muscles. Aging the meat 14 days prior to being irradiated did not greatly improve the flavor. An irradiation treatment was found to improve the tenderness of both the *semitendinosus* and *longissimus dorsi* muscles. No improvement in flavor, aroma, or texture was observed when beef was irradiated prior to the on-set of rigor. (auth)

21926 (AD-248992) RADIOACTIVITIES PRODUCED IN FOODS BY HIGH-ENERGY ELECTRONS. Report No. 11 (Technical Progress), January 15, 1958–March 31, 1960. W. H. Newkirk, H. D. Smith, and R. A. Glass (Stanford Research Inst., Menlo Park, Calif.). Contract DA19-129-qm-1100. 105p.

A computer program was developed to calculate radioactivities produced in foods during sterilization with high-energy electrons. Equations describing electron and x-ray interactions with food were set up and used as a basis for programming operations. The entire program consists of five separate codes which when performed in the given sequence calculate the induced radioactivities. The program was used to check experimental measurements and to examine the effect on induced radioactivities of depth of penetration within the food, electron beam energy, and composition of the irradiated medium. The five machine codes generate data on production of x rays, processes occurring to x rays, net x-ray spectra at each depth, density of radioactive nuclides produced by x rays, and x-ray spectra equivalent to electrons for electron direct field interaction calculations. Seven calculations were made to obtain values for comparison with experimental results from irradiations of aqueous solutions of food elements with 24-Mev electrons. The radioactivities were produced by (γ ,n) photo-nuclear reactions and (γ ,pn) reactions. The agreement with experiment appeared to be good. Three further calculations for aqueous solutions were performed to show the decrease of radionuclide production with decrease in electron-beam energy from 24 to 18 to 12 Mev. These calculations demonstrated a reduction of about a factor of forty in the radioactivity produced by 12-Mev electrons compared to that produced by 24-Mev electrons. Three additional 24-Mev calculations were performed with water, green beans, and ground beef to illustrate that radioactivity production

does not depend on food media composition. Finally, the ground beef medium and 24-Mev electrons were utilized for calculation of the (γ ,n) reaction products, C^{11} , Na^{22} , Mn^{54} , Fe^{53} , Fe^{55} , and I^{126} . (auth)

21927 (AD-251493) COMPARATIVE RESISTANCE OF SELECTED STRAINS OF *Cl. BOTULINUM* IN SELECTED FOOD PRODUCTS. Report No. 7 (Progress), November 15, 1959–February 14, 1960. E. Wheaton and G. B. Pratt (American Can Co., Barrington, Ill.). 8p.

A statistical analysis and conclusions of the effect of 5 foods on 5 strains of *Cl. botulinum* are given. The results on the destruction of curve of approximately 60×10^9 spores of *Cl. botulinum* are presented. (auth)

21928 (AD-251553) STUDIES ON PHYSICAL AND CHEMICAL MODIFICATION OF PROTEINS FOR THE PREVENTION OF IRRADIATION OFF-FLAVORS IN MEAT. Report No. 7 (Annual) [for] May 15, 1959–May 14, 1960. A. L. Tappel (California. Univ., Davis). Contract DA-19-129-QM-1172. 11p.

Radiolytic production of ammonia, amide, and carbonyls in cytochrome c, hemoglobin, and glutathione and of peroxides in amino acids, peptides, and proteins was studied. Malonaldehyde determinations in irradiated chicken and beef samples are reported. Amino acid lability and composition in irradiated glutathione were determined. (D.L.C.)

21929 (AD-251576) STUDIES OF BEEF RADIATION FLAVOR USING A CONCURRENT RADIATION DISTILLATION TECHNIQUE. Report No. 4 (Annual), May 1, 1959–April 30, 1960. S. A. Goldblith (Massachusetts Inst. of Tech., Cambridge. Div. of Sponsored Research). Contract DA-19-129-QM-1374. 24p.

The volatile components produced by concurrent radiation-distillation at 5 megarad of raw ground beef were studied in an effort to identify the substances responsible for the characteristic unpleasant odor of beef preserved by radiation. It was proved that 3-methylthiopropionaldehyde (methional) is a major component of the mixture of at least 12 substances detected, and that it makes a major contribution to the unpleasant odor of irradiated beef. The synthesis of methylthioacetaldehyde, ethylthioacetaldehyde, and 2-methylthiopropionaldehyde is reported. (auth)

21930 (AD-251676) USE OF VARIOUS AMOUNTS OF RADIATION AND HEAT PROCESSING IN THE PRESERVATION OF CANNED FOODS. Report No. 15 (Progress), January 1, 1960–June 30, 1960. E. F. Caldwell (Quaker Oats Co. Research Labs., Barrington, Ill.). 11p.

Experiments on the determination of effective electron dose penetration at various depths of agar as measured by percent survival of *Bacillus stearothermophilus* were continued. Reference depth-dose curves were prepared using cobalt glasses and plastic organic dye dosimeters, the latter being an attempt to minimize error caused by the energy dependence of the relatively higher density cobalt glasses. Curves of percent survival as a function of dose received show a tendency toward high survival at depths over 1.5 cm, even when the dose was determined by plastic dosimeters. Little difference was noted in the percent survival as a function of dose as measured by either glass or plastic at agar depths of 0.5 to 1.5 cm. (auth)

21931 (AD-251679) EFFECTS OF IRRADIATION OF FRESH FRUITS AND VEGETABLES AND DAIRY PRODUCTS. Report No. 3 (Progress), November 1, 1959–

April 30, 1960. W. L. Hock (National Dairy Products Corp. Research and Development Div., Glenview, Ill.). 2p.

Canned raw whole milk was irradiated at doses up to 4.5 Mrad. The number of bacteria was reduced from 5.35×10^6 to less than 1 per ml at 1.6 Mrad, but the flavor was one of burnt feathers and rancidity. Subsequent passage of the irradiated milk through a batch-type deodorizer eliminated most of the burnt feather flavor, but the rancid flavor persisted. (auth)

21932 (CEA-1860) ABSORPTION DE RADIOELEMENTS DU SOL PAR DIVERS LEGUMES CULTIVES DANS LES CONDITIONS DE LA PRATIQUE. (Absorption of Radioelements from the Soil by Various Vegetables Grown Under Normal Condition of Cultivation). (France. Institut National de la Recherche Argonomique, Paris and France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1961. 31p.

Various vegetables were cultivated in 4 different types of soil, having received, or receiving periodically, Sr^{90} or Cs^{137} in fairly strong doses to facilitate the measurement of the fraction of these radioelements taken up by the vegetables. In sandy soil, whole plants absorbed 2 to 3% of Sr and 3 to 9 ppt of Cs approximately; in clay soils, 1 to 6 ppt of Sr and 0.2 to 2 ppt of Cs; Cs, however, migrated relatively more than Sr in fruits or storage organs. The experiments confirmed that the quotient of the ratios Sr^{90}/Ca in the vegetables and in the plowed layer varies comparatively slightly; there would be a certain safety margin in assuming this ratio to be slightly above unity (to be confirmed after homogenizing the plowed layer). In view of the fact that in an arid climate it is necessary to apply several tens of liters of irrigation water (up to 50) in order to produce 1 kg of vegetables (fresh whole plants) and that furthermore, the radioelements of the residue from the crop harvest return to the soil, it can be expected that the limit of accumulation 1 kg of certain vegetables will contain as much of each radioelement as several tens of liters of irrigation water. (auth)

21933 (QMFCIAF-38-60) RESPONSE OF RATS FED VARIOUS DIETS TO ACUTE X-IRRADIATION. Interim Report. Doris Howes Calloway, A. H. Munson, and Harry Spector (Quartermaster Food and Container Inst. for the Armed Forces, Chicago). Dec. 1960. 35p. (AD-248560)

Rats were fed a variety of basal diets and supplements for 2 weeks before and 30 days after whole-body exposure to single doses of 700 to 1000 r of x radiation. No consistent superiority of any dietary treatment was seen using survival as the criterion. There was a tendency toward prolonged survival time in the presence of high vitamin levels and raw Brassicaceae vegetables. Scattered data on enzyme activities, morphologic characteristics and reproductive performance did not clearly differentiate diet groups. (auth)

21934 (TID-12876) PROGRESS REPORT NO. 21 ON [BIOLOGICAL RESEARCH], NOVEMBER 1, 1960-APRIL 30, 1961. (New England Deaconess Hospital, Boston). Contract AT(30-1)-901. 39p.

Preliminary results are presented from studies in which radiation and tritiated thymidine were used for tracing the migratory courses of the primitive cells that make up the assemblies of neurons and glia that ultimately compose the brain, retina, and spinal cord. Data are included on mechanisms of radioinduced malformations and the nature of the radiosensitive cells in the developing nervous system. Results are presented from studies on the radiosensitivity of three selected types of human tumor transplanted to

hamster cheek pouches, the effects of chronic whole-body radiation exposure on the development of leukemia and other neoplasms in mice, the cause of atypical nuclei in lymphocytes, and the pathological effects of I^{131} in the thyroid gland. A long-range study was initiated on mortality and radiation exposure in radiologists. Lists are included of 49 publications and 45 speeches by staff members during the period covered by this report. (C.H.)

21935 (CEA-tr-R-546) APPAREILLAGE DE PROTECTION POUR LE DEPOT DE SOURCES RADIOACTIVES CLOSES. (Protective Device for Storing Closed Radioactive Sources). A. Ya. (Ia.) Berlovskii (Berlovsky). Translated into French by S. Tarassenko from Vestnik Rentgenol. i Radiol., 34: 61-5(1959). 9p.

A small shielded stand for manipulation of stored radiotherapy sources is described. It consists of a Pb box, a cover, a mirror, a dish for radioactive material, a manipulator, and a carrier for placing radioactive materials in containers. For better interior viewing there is an electric light. An opening with a lead plug is provided for examining, picking up or moving the sources. The opening is funnel-shaped. Manipulation procedures for use of the stand are described. (T.R.H.)

21936 (JPRS-3398) CYTOLOGY. Translation of Tsitologiya, Volume I, No. 3, 1959. 158p.

21937 CESIUM 137 AND ITS GAMMA RADIATION IN TELERADIOTHERAPY. R. Thoraeus (Karolinska Sjukhuset, Stockholm). Acta Radiol., 55: 385-95(May 1961). (In English)

A review of the characteristics of cesium-137 radioactivity, including partial comparison with cobalt is given. The measurement of cesium gamma radiation by means of an extensively calibrated substandard is described and the experimental results, particularly the half-value layers of some materials, are presented. Certain clinically important properties of the radiation, the radiation protection using radioactive cesium, and the result of a determination of the peak energy of the roentgen radiation equivalent in penetration to the cesium gamma radiation, are discussed. (auth)

21938 BIOLOGICAL EFFECTS OF MAGNETIC FIELDS. NEGATIVE RESULTS. John E. Eiselein, Helen M. Boutell, and Max W. Biggs (Univ. of California, Livermore). Aerospace Med., 32: 383-6(May 1961). (UCRL-6102)

Attempts to demonstrate a significant biological effect of a sustained magnetic field (8800 to 14400 gauss) on White Swiss mice were unsuccessful. Under the conditions of the experiments, the magnetic field did not alter the rate of growth of an Ehrlich's ascites tumor, significantly change the rate of young male animal growth, or significantly change the white blood count. (auth)

21939 CARCINOID OF THE RECTUM. A CASE REPORT WITH OBSERVATIONS ON RADIOSENSITIVITY OF NODULAR METASTASES TO THE SKIN. Merall Roth (Veterans Administration Hospital, San Francisco). Am. J. Roentgenol., Radium Therapy Nuclear Med., 86: 97-102 (July 1961).

A case of carcinoid of the rectum is described. The patient was asymptomatic for five years following an abdominoperineal resection after which there were widespread metastases to bone, skin, viscera, spinal cord, and brain, with a fatal termination after eight years. There were dense osteoblastic metastases to the axial skeleton (skull excepted) and multiple skin nodules. Radiosensitivity studies on the nodules demonstrated a minimum disappearance dose of 2500 r in air for one day and 5000 r in air for

six days. The literature for carcinoids is reviewed briefly with particular reference to rectal lesions and to interesting hormonal effects exhibited by some of these tumors. (auth)

21940 THE EFFICIENCY OF AUTORADIOGRAPHIC STRIPPING-FILM APPLIED TO TISSUE SECTIONS CONTAINING TRITIATED THYMIDINE. Walter E. Kisilewski, Renato Baserga, and John Vaupotic (Argonne National Lab., Ill.). *Atomlight*, No. 18, 1-6(May 1961).

Procedures are described for preparing high-resolution radioautograms of tissue sections containing tritiated thymidine. The type and number of labeled cells and the number of Ag grains above each labeled cell can be determined with reasonable accuracy. Results are reported from an attempt to correlate the number of developed Ag grains in a stripping-film emulsion and the concentration of tritium in the labeled cells of an underlying tissue section. (C.H.)

21941 AUTORADIOGRAPHY OF WHOLE ANIMALS AS AN EXPERIMENTAL TOOL IN PHARMACOLOGICAL RESEARCH. V. Nair and L. J. Roth (Univ. of Chicago). *Atomlight*, No. 18, 7-10(May 1961).

Procedures are described for studies on the fate of drugs labeled with C^{14} , S^{35} , I^{131} , or tritium in mice by whole-body radioautography. The radioautograms were prepared from sagittal sections. By comparing the radioautograms with corresponding sections, relative distribution values are obtained. (C.H.)

21942 THE BIOLOGICAL HALF-LIFE OF K^{42} IN THE COW AND THE OBESE PIG. G. A. Robinson, K. G. McNeill, R. M. Green, and H. C. Rowsell (Ontario Veterinary College, Guelph, and Univ. of Toronto). *Can. J. Biochem. and Physiol.*, 39: 1125-31(July 1961). (In English)

Potassium-42 was used as a tracer of the total exchangeable body potassium in 6 cows and 5 large sows. One mc of K^{42} solution was injected intravenously into each animal, and samples of urine and feces were collected in 8-liter plastic pails, at intervals, for 70 hours. The radioisotope content of the samples was determined by dipping an unshielded NaI scintillometer into the pails to a constant depth. Background error was reduced by setting the discriminator levels to accept only pulses corresponding to the photopeak of the K^{42} emission. The rate of excretion of K^{42} decreased for approximately 16 hours, then appeared to remain constant for the rest of the experiment. Means of biological half-life values, as calculated for the period from 22 to 70 hours, were 10.5 days for the cows and 45.6 days for the pigs. Percentages by weight of total K in the animals were 0.21 for the cows and 0.24 for the pigs, as estimated from flame photometric determination of urinary potassium and biological half-life values. (auth)

21943 STUDIES ON THE METABOLISM OF RADIO-ACTIVE STRONTIUM ($Sr^{89,90}$). II. INFLUENCE OF VARIOUS CHEMICAL AGENTS UPON THE DISTRIBUTION OF $Sr^{89,90}$ IN ANIMALS. K. Torizuka (Kyoto Univ.). *Naika Hōkan*, 6: No. 2, 76-83(1959).

The influence of various chemical agents upon the distribution in the body and the daily excretion of subcutaneously injected $Sr^{89,90}$ was examined in male rats weighing 135 to 150 g. EDTA $_4Na$, EDTA Ca, sodium citrate, zirconium citrate, calcium chloride, BAL, and parathyroid hormone (kakerbin) were administered, either simultaneously with the radioelements, or 4 days after the injection of radioisotopes. When EDTA $_4Na$, EDTA Ca, sodium citrate, and zirconium citrate were administered simultaneously with $Sr^{89,90}$, there was a statistically significant increase in urinary excretion of radioactivity, that is, a

decrease of $Sr^{89,90}$ deposits in the skeleton. On the other hand, calcium chloride, BAL, and kakerbin had no effect on strontium metabolism. When EDTA $_4Na$, EDTA Ca, sodium citrate, and zirconium citrate were administered 4 days after injection of radioisotopes, an increase in the urinary excretion of the radioisotopes was observed. Zirconium citrate caused the greatest increase in excretion. (Abstr. Japan. Med., 1: No. 1, 1960)

21944 STUDIES ON THE METABOLISM OF RADIO-ACTIVE STRONTIUM ($Sr^{89,90}$). III. STUDIES ON THE BINDING OF Sr^{89} AND BONE TISSUE IN VITRO. K. Torizuka (Kyoto Univ.). *Naika Hōkan*, 6: No. 2, 84-95(1959).

The dye bath method was used for the study of the binding of Sr^{89} with guinea-pig bone slices in vitro, the mechanism of action of various chemical agents, such as EDTA $_4Na$, EDTA Ca, sodium citrate, zirconium citrate, calcium chloride, BAL, and parathyroid hormone, as accelerators of Sr^{89} excretion. When the bone slices were incubated at 37.0°C in physiological saline solution or 1/5 M tris buffer solution (pH 7.24) containing $Sr^{89}Cl_2$, the binding rate of Sr^{89} and bone slices was higher than at 27.4°C, that is, this reaction was an endothermic one. Sr^{89} , like calcium deposits in the skeleton, was first bound with the organic fraction of the bone tissue and then migrated to the mineral fraction. Sodium citrate accelerated the excretion of Sr^{89} in vivo, but it was not effective in the binding of Sr^{89} and bone slices in vitro. Zirconium citrate and calcium chloride act in competition or cause an ion-exchange reaction with Sr^{89} in the organic fraction of bone tissue. EDTA and BAL act as chelating compounds between the chemical reaction and Sr^{89} . Parathyroid hormone had no effect on the binding of Sr^{89} and bone slices in vitro. (Abstr. Japan. Med., 1: No. 1, 1960)

21945 STUDIES ON THE METABOLISM OF RADIO-ACTIVE STRONTIUM ($Sr^{89,90}$). IV. AUTORADIOGRAPHIC STUDIES ON THE DEPOSITION OF Sr^{90} IN GUINEA-PIG BONE. K. Torizuka (Kyoto Univ.). *Naika Hōkan*, 6: No. 3, 184-8(1959).

The concentration of strontium in different parts of the bone 1 day, 10 days, 1 month, and 2 months after the subcutaneous injection of Sr^{90} in male guinea pigs 1, 3, and 6 months old was studied using autoradiographs made by the contact and stripping methods. Strontium was concentrated in the areas where active bone formation was taking place at the time of injection. These areas were subsequently displaced by the formation of new nonradioactive bone and Sr^{90} deposited in these areas was finally removed by the normal process of resorption. In younger animals this turnover was remarkable. The areas where Sr^{90} was concentrated were liable to considerably greater radiation damage than the estimation of amount retained per unit weight of the skeleton, assuming an even distribution. (Abstr. Japan. Med., 1: No. 1, 1960)

21946 TRIAL PRODUCTION OF A WATER-EQUIVALENT SOLID PHANTOM MATERIAL. Y. Onai and G. Kusomoto (Hospital of the Cancer Inst., Tokyo). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 1012-15(1959).

'Mix D' phantom wax, which was developed by Jones and Raine, was made by the authors but its density was only 0.96 g/ml. In order to increase the density, the quantities of paraffin and polyethylene were reduced and instead pine resin, with a density of 1.07 g/cu cm was added to the composition of 'Mix D.' The composition of the new material by weight is paraffin wax 50%, polyethylene 25%, pine resin 16.2%, magnesium oxide 6.4% and titanium dioxide 2.4%. The density of this material became 0.99 g/ml.

The effective atomic number was estimated by taking a radiograph of a block of the material immersed in water. Using 50 kvp x rays, a block of the new material was not imaged on the radiograph. By irradiating x rays of 65 kvp, 130 kvp, and 180 kvp and Co^{60} γ rays, comparative tests were made on transmission of rays and 135-degree scattering under the similar arrangement between water and the new phantom material. The new material gave the same absorption and scattering as a water phantom within the limits of experimental error. (Abstr. Japan. Med., 1: No. 1, 1960)

21947 PENUMBRA PROJECTED ON CONTOUR OF RADIATION FIELD. STUDIES ON Co^{60} TELETHERAPY. [PART] IV. S. Okajuma (Magoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1392-1401(1959).

An investigation was made of the size of the penumbra of the radiation field, integral dose, and treated region, when a rotation teletherapy unit housing 1000 c of Co^{60} is used for clinical practice. Simple formulas obtained theoretically are given for getting the value of the penumbra of the contour of the radiation field and integral dose when the distance between the radiation source and defining aperture is changed. An experiment using a victoreen chamber proved these formulas to be correct. The size of the penumbra as well as the integral dose increased rapidly as a diaphragm approached the source. Tapered extension collimeters attached to the ordinary collimeter reduced this undesirable penumbra, and the dose distribution became better than without using the extension cone. A decrease of the integral dose resulted as well. In view of the amount of the integral dose, the increase in the skin-source distance was not always effective unless the corresponding cone was used. The necessity for determining the permissible variation of dose distribution in the area of the treated region and for making the proper isodose charts in the various types of radiation is stressed. (Absts. Japan. Med., 1: No. 7, 1960.)

21948 APPLICABILITY OF NEUTRON CAPTURE THERAPY WITH COLLOIDAL BORON. T. Miyakawa and N. Watanabe (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2104-14(1960).

The possibility of neutron capture therapy for malignant tumors was discussed. A new, very simple and sure preparation method was described for colloidal boron, which is scarcely toxic for the human body. The size of colloidal boron is in the range of 2.3 to 295 μ measured electron-microscopically. It is relatively equally distributed in tumor tissue over the range of millimeters from the injected point. A thermal neutron flux of 10^6 n/sq cm/sec was required to give 500 rem for 60 min in the treatment of a malignant tumor when colloidal natural boron was injected directly into the tumor, while a flux of 10^5 to 10^6 n/sq cm/sec was required when colloidal boron enriched with B^{10} was used. The authors concluded that the thermal neutron capture therapy can be performed for malignant tumors with a flux of 10^6 n/sq cm/sec. (Absts. Japan. Med., 1: No. 7, 1960.)

21949 MEASURABLE INTERNAL RADIATION FROM A BETATRON DURING EMISSION OF HIGH-ENERGY ELECTRONS. II. DATA CONCERNING PROTECTION PROBLEMS. P. G. Paleani Vettori and F. Pigorini (Università, Rome). Nuntius Radiol., 27: 125-37(Feb. 1961). (In Italian)

The radiations measured in the proximity of the 15-Mev-SRW Betatron of the Radiological Institute of the University of Rome have been studied from the standpoint of the protection problems. The ionization values at the surface and in the depth shown by a para rubber mannequin placed in

correspondence to different points are reported. The importance of the observed phenomena is discussed as far as the dose for the critical organs is concerned. (auth)

21950 STUDY ON THE RADIOGOLD PREPARED EXPERIMENTALLY IN JAPAN. Fumio Yamada (Osaka City Univ.), Shigekazu Maeda, Hiroyoshi Ikejiri, Toshiyuki Jikuhara, Isao Kawai, Masataka Morimura, Shuhei Okabe, Hidekazu Tsuchiya, Sadao Teramura, Shoji Nakayama, Hichikatu Naito, Seiji Takeuchi, Shinsuke Ose, Yoshio Yoshimura, Yasuo Minaki, and Kunio Kurata. Radioisotopes (Tokyo), 8: 34-42(Mar. 1959). (In Japanese)

Sterilized and pyrogen free gold-198 colloid was produced from irradiated gold foil and was examined biologically and clinically from the viewpoint of practical use. The colloid was prepared by reduction with glucose or ascorbic acid and was adjusted to a gold concentration 10 mg/ml and particle size 3.6 to 9.5 μ . It was confirmed that the colloid contained no ionic gold, and its half life and radiation energy were practically equal to values reported in literature. Results are presented for the following biological examinations: local deposition, leukocyte numbers, hematological examination, distribution in the mouse, radioautograph, effects on experimental ascites cells, effects on HeLa cells, and the effects on experimental tumor. (N.W.R.)

21951 SOME CONSIDERATIONS ON THE SAFE TRACER DOSE OF THE COLLOIDAL ^{198}Au CLEARANCE METHOD. Ryoto Suzuki, Togo Ouchi, Kengo Nakai, and Tatsuma Nakajima (Nihon Univ., Tokyo). Radioisotopes (Tokyo), 8: 65-71(Mar. 1959). (In Japanese)

The practicable safe tracer dose of colloidal gold-198 for measuring liver blood flow in humans is found to be 0.1 μ c/kg. This result was obtained by giving 30 μ c of colloidal gold-198 to dogs intravenously. 24 hours later the dogs were sacrificed and the distribution of the colloidal gold-198 was determined in selected tissues. The liver uptake is 90.65%, and the differential absorption ratio of liver is 36.2%. From these data the safer tracer dose is calculated as 0.088 to 0.125 μ c/kg. In the latter the maximum permissible exposure is 0.1r/day and in the former 0.3r/day. (N.W.R.)

21952 MEASUREMENT OF ISODOSES FOR COBALT-60 PENDULUM IRRADIATION ON A SKULL PHANTOM. Eberhard Bottler and Eberhard Löhr (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 115: 326-32(June 1961). (In German)

A film densitometric method for dose measuring on a skull phantom with the possibility for a simultaneous dose registration in different levels is described. The results show, that with cobalt-60 pendulum radiation it is possible to reach a high tumor dose on a circumscribed area of the brain with the greatest possible care of the surrounding region. (auth)

21953 THE INTRODUCTION OF TRITIUM IN SOME SUGARS DURING PHOTOSYNTHESIS. H. Simon and A. Trebst (Technische Hochschule, Munich). Z. Naturforsch., 16b: 285-7(Apr. 1961). (In German)

A study was made on chloroplasts and chlorella to determine how much T was bound during photosynthesis per C^{14}O_2 fixed. The sugar phosphate isolated and identified through paper chromatography and autoradiography were dephosphorylated, and the free sugar was rechromatographed and eluted. The tritium and C^{14} were determined. The C^{14}/T ratio found in the sugars was compared with the C^{14}/T ratio in the bicarbonate- C^{14} and HOT used. The results are tabulated for various sugars. The C^{14}/T ratio in the photosynthetic products is smaller than in the substrate.

This indicates an enrichment in tritium. In chlorella only half as much T is bound as in chloroplasts. (J.S.R.)

21954 A MANUAL FOR NUCLEAR MEDICINE. E. R. King and T. G. Mitchell. Springfield, Illinois, Charles C. Thomas, 1961. 412p. \$13.50.

Techniques and experiments used in the clinical radioisotope field are outlined. Every technique and experiment described has been tested and applied for optimum practicality. The manual is designed for use as a teaching guide to nuclear medicine, a laboratory guide to clinical radioisotope practice, and as a reference guide to nuclear physics. There are discussions on the significance of abnormal results of the various radioisotope tests. (N.W.R.)

21955 RADIATION IN AGRICULTURAL RESEARCH AND PRACTICE. K. Kaindl and H. Linser (International Atomic Energy Agency, Vienna). 1961. 48p. (STI/Pub/15/10)

The main use of ionizing radiation in agriculture is in connection with plants, and the present survey deals in particular with that subject, and especially with plant breeding and the controversial phenomenon of stimulation effects. It discusses the possible use of radiations for soil measurement and the obtaining of physical data relating to soil. Thus far radiation has not been applied directly to animals; but it has been applied indirectly in the form of pest control over extensive areas, e.g., by the sterilization of insects. No discussions are included in the survey on the effect of ionizing radiations, x rays and their fundamental radiobiological effects on plant or animal cells, and the extensive application of radioactive isotopes as tracer elements. (auth)

Biochemistry, Nutrition, and Toxicology

21956 (TID-12877) A STUDY OF THE MECHANISMS OF PROTEIN AND NUCLEIC ACID METABOLISM AND THEIR RELATIONSHIP TO RADIATION DAMAGE. Progress Report, June 1, 1960–May 31, 1961. (Massachusetts General Hospital. John Collins Warren Labs., Boston). Contract AT(30-1)-2643. 17p.

Previous studies have shown that, as an intermediate step in protein synthesis, activated amino acids become attached to soluble, or transfer-RNA molecules. Results are presented from studies on the effect of ultraviolet radiation on transfer-RNA, the relationship between nucleic acid metabolism and cell division in irradiated tissues, studies using C^{14} -thymidine to trace DNA synthesis during hepatic regeneration in rats of various ages, and studies on the toxic effect of 5-bromodeoxyuridine on cultured epithelial cells. The effects of x radiation on mammalian wound healing was studied from the point of view of the mechanism of wound contraction and the site of origin of fibroblasts of wound repair. Histologic studies of full-thickness wounds in guinea pigs irradiated with 750 r at various times before and after wounding included terminal profusion with carbon as an aid to studying radiation effects on capillary proliferation. Wound contraction was found to be retarded by radiation to a degree which varied with the time of radiation with respect to time of wounding. A list is included of 26 publications during the period covered by this report. (C.H.)

21957 (TID-13052) Ca-45 AND Sr-85 METABOLISM IN MAN. Progress Report for Period, May 20, 1960–June 1, 1961. (Creighton Univ., Omaha). Contract AT(11-1)-587. 12p.

Summaries and apparent trends are given from studies

on osteoporosis in humans and rats. The calcium balances, handling, and equilibrium in these subjects were studied along with Sr–Ca discrimination. *In vivo* bone localization and quantization of gamma emitting bone seekers was also investigated. (J.R.D.)

21958 (UR-549) THE CELL MEMBRANE AS THE SITE OF ACTION OF HEAVY METALS. Aser Rothstein. DISCUSSION: THE INTERACTION OF METALS WITH EPITHELIA. T. W. Clarkson (Rochester, N. Y. Univ. Atomic Energy Project). May 13, 1959. Contract W-7405-eng-49. 47p.

The mechanism of action of heavy metals on cells and the various possible modes of interference with cell membrane functions are discussed. Examples treated include the action of Hg and Cu on the sugar uptake and respiration of the muscle cell, the action of molybdate and tungstate on surface enzymes in yeast, the action of UO_2^{2+} on sugar uptake and surface enzymes in yeast, and the breakdown of the membrane by Hg in yeast. In a separate discussion, the interaction of metals with epithelial tissue is treated and the following particular examples considered: action of Hg^{2+} and Cu^{2+} on NaCl transport in frog skin and action of Cd^{2+} on the human kidney. (D.L.C.)

21959 (UR-590) THE INHALATION TOXICITY OF INDIUM SESQUIOXIDE IN THE RAT. L. J. Leach, J. K. Scott, R. D. Armstrong, L. T. Steadman, and E. A. Maynard (Rochester, N. Y. Univ. Atomic Energy Project). Feb. 10, 1961. Contract W-7405-eng-49. 29p.

Albino rats were exposed to a In_2O_3 dust aerosol of mean concentration 64 mg/m³ for 3 months. The retention of In in the tissues and the mobilization of In from the lungs and tracheobronchial lymph nodes were determined. The results indicate chemical toxicity. (D.L.C.)

21960 DISTRIBUTION OF RADIOCESIUM IN MICE. An Autoradiographic Study. Arne Nelson, Sven Uilberg, Harry Kristoffersson, and Curt Rönnbäck (Research Inst. of National Defence, Sundbyberg, Sweden and Royal Veterinary Coll., Stockholm). Acta Radiol., 55: 374–84 (May 1961). (In English)

The distribution of Cs^{137} in mice was investigated at different intervals after injection. Sagittal sections through the whole frozen animal were cut and dried in a freeze room. Radioautograms were prepared of each section. The Cs^{137} disappeared rapidly from blood and the greatest accumulation appeared in cartilage. Data are presented on the uptake in all tissues and in fetuses. (C.H.)

21961 COMPARATIVE ELIMINATION OF RADIOCESIUM AND RADIOSTRONTIUM BY GRASSHOPPERS. D. A. Crossley, Jr. and Jay H. Schnell (Oak Ridge National Lab., Tenn.). Ann. Entomol. Soc. Am., 54: No. 2, 459–61 (Mar. 1961).

A difference was found in the relative accumulation of Sr^{90} and Cs^{137} by insects at the White Oak Lake bed, a contaminated radioactive area at the Oak Ridge National Laboratory, Oak Ridge, Tenn. Insects reached Cs^{137} concentrations which were almost as high as concentrations in the plants, but Sr^{90} concentrations in the insects were nearly an order of magnitude lower than the corresponding plant concentrations. This difference was explained by results from laboratory studies with Sr^{85} and Cs^{137} in grasshoppers, which showed that Sr^{85} was eliminated much more rapidly than Cs^{137} . (C.H.)

21962 MEASUREMENT OF THE INCORPORATION OF RADIOACTIVE AMINO ACIDS INTO PROTEIN BY A FILTER-PAPER DISK METHOD. Rusty J. Mans and G. David Novelli (Oak Ridge National Lab., Tenn.). Arch. Biochem. Biophys., 94: 48–53 (July 1961).

A rapid and sensitive method is described for the measurement of amino acid incorporation in cell-free systems. Samples of a reaction mixture were acid-precipitated on filter-paper disks, washed and extracted to remove unincorporated radioactivity, and then counted directly in a liquid scintillation spectrometer. The method is applied to both C^{14} - and H^3 -labeled proteins. (auth)

21963 INCORPORATION OF LABELED AMINO ACIDS INTO A LIPID FRACTION OF THE ISOLATED RAT LIVER. Ottavio Barnebel and Renata Ferrari (Università, Ferrara, Italy). Arch. Biochem. Biophys., 94: 79-84 (July 1961).

When the isolated rat liver is perfused with rat blood, containing labeled amino acids, the phosphatidopeptide fraction becomes quickly radioactive and reaches a maximum in its radioactivity after a few minutes. The labeling is inhibited by several metabolic inhibitors. Autoradiographic experiments showed that the radioactivity of the phosphatidopeptide fraction is due to incorporation of the labeled amino acids in the peptide moiety. (auth)

21964 PLUTONIUM INHALATION STUDIES. II. EXCRETION AND TRANSLOCATION OF INHALED $Pu^{239}O_2$ DUST. W. J. Bair and B. J. McClanahan (General Electric Co., Richland, Wash.). Arch. Environmental Health, 2: 648-55 (June 1961).

Of 4 dogs given an inhalation exposure to a $Pu^{239}O_2$ aerosol, 2 were killed immediately after exposure and 2 were killed 39 weeks after exposure. All urine and feces were collected on the latter 2 dogs for determination of plutonium content. All tissues from all dogs were similarly assayed. Immediately after exposure about 75% of the total Pu deposited was found in the lungs, 23% in upper respiratory passages and gastrointestinal tract, and less than 2% in all other tissues. The daily excretion of Pu in urine and feces was described by power function equations. However, the day-to-day variation in amounts excreted were as great as 20-fold or more. Of the total deposited dose only about 1.5% was excreted in urine during a 39-week period. One dog excreted 55% in feces and another 39%. Thirty-nine weeks after exposure the lungs and the bronchial and mediastinal lymph nodes of one dog contained 43% of the total initial dose, almost equally distributed between the 2 tissues. In the other dog the lungs contained 53% and the lymph nodes 7% of the dose. All other tissues in both dogs contained about 0.5% of the dose. The results were compared with published results for mice and rats which cleared plutonium particles from lung at more rapid rates than dogs. The smaller particle size of plutonium inhaled by the rodents may explain the differences. The data demonstrate the insolubility of PuO_2 in respiratory tissues and emphasize the major role which the lymphatic system plays in the clearance of insoluble materials from the lungs. Comparison of the average concentrations of Pu in lung and lymph node leads to the conclusion that lymph nodes will receive a greater radiation dose than lung. However, comparison of average concentrations may be misleading because it implies uniform distribution of Pu within a tissue and does not allow for localization of plutonium in hot spots which cause microscopic volumes of tissue to receive many times greater radiation doses than the average. (auth)

21965 THE AUTORADIOGRAPHIC STUDY OF THE FIXATION OF CHROMIUM 51 IN THE MOUSE IN VIVO. Jacques Ingrand (Centre d'Etudes nucleaires, Saclay, France). Compt. rend., 252: 218-19 (Jan. 4, 1961). (CEA 1914) (In French)

Chromium-51, injected in the mouse in the form of sodium chromate, is fixed electively on the hepatic and splenic tissues and on the bone tissue in growth. (auth)

21966 DO TANNOID MATERIALS MODIFY THE DIGESTIVE ABSORPTION OF STRONTIUM. F. M. Gleize, M. J. Millard, G. Michon, and B. Prpic (C.E.N., FAR., Saclay, France). Compt. rend. soc. biol., 154: 2045-7 (1960). (In French)

The effect of tannoid materials on the digestive absorption of strontium was studied on rats receiving an oral administration of $2 \mu\text{C}/\text{cm}^3$ of Sr^{90} . In one series of experiments the rats, immediately after the Sr administration, received a single dose of wine or raisin juice. In the second series the rats were given the wine or raisin juice for 7 days before and for 4 days after the administration of the Sr^{90} . The elimination of the Sr was followed daily up to the 15th day. The results show that the tannoid materials do not appear to modify the digestive absorption of strontium. (J.S.R.)

21967 PRODUCTION OF CARBON DIOXIDE AND LACTIC ACID FROM RADIOACTIVE GLUCOSE BY TISSUE IN CULTURE. E. Broda, W. Rücker, O. Suschny, G. A. Abdel-Tawab, and G. Kellner (Universität, Vienna). Exptl. Cell Research, 23: 555-64 (Apr. 1961). (In English)

Chick embryo mesenchyma tissue in culture was incubated in growth-promoting nutrient media with radioactive glucose, the carbon dioxide and the lactic acid isolated, and their radioactivities determined with the gas Geiger counter. Both synthetic and natural media were used. Some experiments were also done with tissue kept in salt solution. As the number of cells per unit quantity of glucose increases, glycolysis per cell decreases and respiration per cell increases, as far as glucose serves as the substrate. Thus the Crabtree effect in tissue culture is at least partly due to a switch from the utilization of glucose by respiration to its utilization by glycolysis. The effects of controlled damage by trypsin resemble those of an increase in the supply of glucose. In all experiments with growth-promoting media more glucose is glycolyzed than respired, but more free energy is usually derived from respiration than from glycolysis. The total amount of free energy derived from glucose, per cell, does not change significantly as the supply of glucose per cell is varied. No major differences in the utilization of glucose are observed in the given conditions between monolayers and solid tissue pieces. (auth)

21968 EFFECT OF RADIOISOTOPES ON TEETH AND THEIR SURROUNDING TISSUE. H. Fujii (Hiroshima Univ.). Hiroshima Igaku, 7: 2717-25 (1959).

Effect of radioisotopes on teeth and their surrounding tissue was studied using human teeth and the lower jaws and teeth of dogs and rats. Radioisotopes such as P^{32} , Ca^{45} , Sr^{90} , I^{131} , and Bi^{210} were deposited in the dentine tissue via the vascular system. The isotopes P^{32} , Ca^{45} , Sr^{90} , and I^{131} were not distributed in the enamel, but Bi^{210} showed specific affinity to it. In spite of no deposition of the isotopes in the dentine tissue before the extraction of teeth, there was much affinity to the dentine tissue in the alveolar bones. There were a large number of metabolic exchanges in the growing bones such as the mandibular process. The deposition of isotopes was seen in a relatively short time in the teeth of young animals. In the healing process of wounds in the teeth, Ca^{45} was transmitted from the capillaries into the wound more than in the usual calcified areas. After calcification the deposition showed an even distribution. (Absts. Japan. Med., 1: No. 7, 1960.)

21969 Ca^{45} UPTAKE BY DOG ERYTHROCYTES SUSPENDED IN SODIUM AND POTASSIUM CHLORIDE SOLUTIONS. Akira Omachi, Raymond P. Markel, and Helen Hegarty (Univ. of Illinois, Chicago). J. Cellular Comp. Physiol., 57: 95-100 (Apr. 1961).

The disappearance of Ca^{45} from the medium was greater when washed dog erythrocytes were suspended in isotonic KCl rather than in isotonic NaCl. Cells stored in a refrigerator for 24 hr or more took up even greater quantities of Ca^{45} when incubated in KCl but cells suspended in NaCl did not show any difference from fresh cells. This result is consistent with the view that competition takes place between Ca and Na ions for binding sites as a consequence of the similarity in ionic radii. Acid-citrate-dextrose and, to a certain extent, heparin appeared to delay the increased uptake by stored cells. Addition of glucose, adenosine, or Nembutal to stored blood had no effect. Fresh cells hemolyzed by saponin or by hypotonic media took up no more Ca than unhemolyzed fresh cells. Calcium uptake in KCl was dependent upon pH, greater amounts being taken up at alkaline pH. In contrast to dog red cells, human and cat erythrocytes did not show differences in uptake in NaCl and in KCl, before or after storage. (auth)

21970 THE EXCHANGE OF RADIOACTIVE MAGNESIUM IN ERYTHROCYTES OF SEVERAL SPECIES. Terence A. Rogers (Stanford Univ., Calif.). *J. Cellular Comp. Physiol.*, 57: 119-21 (Apr. 1961).

Results are reported from *in vivo* and *in vitro* studies on the exchange of Mg^{28} in erythrocytes of rats, dogs, cats, cattle, and man. Data are presented graphically. Results indicate that erythrocytes contain less Mg than other tissues and that Mg is very slowly exchanged. Possible mechanisms involved in Mg exchange are discussed. (C.H.)

21971 THE USE OF CONTINUOUS INFUSIONS OF CALCIUM⁴⁵ AND STRONTIUM⁸⁵ TO STUDY SKELETAL FUNCTION. Clayton Rich, John Ensink, and Harold Fellows (Veterans Administration Hospital, Seattle; Univ. of Washington School of Medicine, Seattle; and Rockefeller Inst., New York). *J. Clin. Endocrinol. and Metabolism*, 21: 611-23 (June 1961).

Intravenous infusions of Ca^{45} of high specific activity were given for 1.7 to 3.3 hours at constant rates to patients with osteoporosis, Paget's disease, parathyroid diseases, and other disorders of skeletal metabolism. During each infusion, the specific activity of the Ca of plasma was found to increase at a constant rate, a result which allowed calculation of the amount of calcium with which the administered Ca^{45} appeared to mix during the infusion (the miscible calcium). The results of this test were reproducible in any given patient, were similar in normal subjects, and appeared to vary characteristically in several different states of altered skeletal metabolism. Similar results were obtained when Sr^{85} was substituted for Ca^{45} . (auth)

21972 INHIBITION OF THYROIDAL I^{131} UPTAKE BY PARABROMDYLAMINE MALEATE. Alton R. Sharpe, Jr. (U. S. Naval Hospital, Portsmouth, Va.). *J. J. Clin. Endocrinol. and Metabolism*, 21: 739-40 (June 1961).

Results of studies in 22 untreated hyperthyroid and euthyroid patients led to the conclusion that the antihistamine, parabromdylamine maleate, will inhibit the thyroidal uptake of I^{131} in some patients. It is suggested that this medication should be discontinued at least one week prior to the performance of an I^{131} uptake test. (C.H.)

21973 EFFECTS OF PREGNANCY ON IODINE METABOLISM IN THE PRIMATE. J. T. Dowling, Donald L. Hutchinson, William R. Hindle, and Charles R. Kleeman (Veterans Administration Center, Los Angeles and Univ. of California Medical Center, Los Angeles). *J. Clin. Endocrinol. and Metabolism*, 21: 779-91 (July 1961).

The effects of pregnancy on several parameters of iodine metabolism in the macaque are similar to the ef-

fects observed during estrogen therapy in nonpregnant humans. These are: an increase in thyroxine binding by the thyroxine-binding globulin, slowing of the fractional rate of thyroxine turnover, and an increase in the concentration of circulating hormone without an appreciable change in the volume of distribution of thyroxine. Net daily hormonal turnover is no different during pregnancy than in the nonpregnant animal. A similar phenomenon was noted in 2 of 3 women similarly studied during and after therapeutic abortions. In the first woman there was an appreciable slowing of the fractional rate of thyroxine turnover during pregnancy, with a return to normal values after abortion. In the 2 other women, who suffered significant intercurrent illnesses, the rates were characteristic of normal nonpregnant subjects. In 1 of these 2 women, the rate was further accelerated during the postpartum follow-up period. Consequently, the net quantity of hormone turned over daily was the same during pregnancy as it was post partum. However, in the other woman the net hormonal turnover was markedly reduced at the time of postpartum follow-up examination. At the time of abortion, the concentration of organic I^{131} in fetal serum was approximately one-fifth that in maternal serum. (auth)

21974 IRON ABSORPTION. MEASUREMENT OF INGESTED IRON BY A HUMAN WHOLE-BODY LIQUID SCINTILLATION COUNTER. Robert van Hoek and Marcel E. Conrad, Jr. (Walter Reed Army Inst. of Research, Washington, D. C.). *J. Clin. Invest.*, 40: 1153-9 (July 1961).

Iron absorption was measured in normal and iron-depleted subjects by using Fe^{59} and a whole-body liquid scintillation counter. Normal iron-replete adult humans absorbed 10% or less of the orally administered test dose. Iron-deficient subjects absorbed 29 to 71%. The method requires a small dose of radioisotope, permitting repeated studies. It provides an index of the rate of iron loss, including loss by bleeding. (auth)

21975 EFFECT OF HIGH CALCIUM INTAKE ON STRONTIUM⁸⁵ METABOLISM IN MAN. Herta Spencer, Margaret Li, and Joseph Samachson (Montefiore Hospital, New York). *J. Clin. Invest.*, 40: 1339-45 (July 1961).

The effect of high Ca intake of varying duration was studied on Sr^{85} metabolism in 14 patients under controlled dietary conditions. The Ca intake of 10 patients was approximately 10 times as high during high intake as during low intake. Tracer doses of Sr^{85} were given orally or intravenously in separate studies during low and high Ca intake to the same subject. The intestinal absorption of orally administered tracer doses of Sr^{85} was of similar magnitude during low and high calcium intake in 7 of 11 patients and was lower in 4 patients during high than during low Ca intake. The addition of Ca to the diet resulted in increased urinary excretion of Ca in most patients. This increase was accompanied by a somewhat higher excretion of Sr^{85} after intravenous doses in 4 of 6 patients, while in general, no increase of urinary Sr^{85} excretion occurred when Sr^{85} was given orally. (auth)

21976 ISOTOPIC SODIUM TURNOVER STUDIES IN MAN: EVIDENCE OF MINIMAL SODIUM (Na^{22}) RETENTION 6 TO 11 MONTHS AFTER ADMINISTRATION. Malcolm G. Smilay, Lewis K. Dahl, Sanford C. Spraragen, and Lawrence Silver (Brookhaven National Lab., Upton, N. Y.). *J. Lab. Clin. Med.*, 58: No. 1, 60-6 (July 1961). (BNL-5106)

Na^{22} and a very sensitive whole-body counting technique

allowed a long term clinical observation in 12 patients who had received small doses of the isotope. Under carefully controlled conditions, the rate of elimination of Na^{22} appeared to be predictably related to NaCl intake. Na^{22} was eliminated in linear fashion until approximately 1% of the original dose remained, thereafter, further elimination continued at a decreasing rate. The small and constant final moiety of Na^{22} suggested that the isotope entered the skeletal system, where sodium exchanges slowly. (auth)

21977 A STUDY OF BLOOD AND URINARY VITAMIN CONCENTRATIONS AND OF FAT BALANCE IN THE RHESUS MONKEY (*MACACA MULATTA*). Jose Eduardo Dutra De Oliveira, John G. Coniglio, Krishna P. Misra, William N. Pearson, J. Ann Efner, and William J. Darby (Vanderbilt Univ. School of Medicine, Nashville). *J. Nutrition*, 59: 515-25 (Aug. 1956).

A study of blood levels, urinary excretion of several vitamins, and fat balance was made in apparently healthy rhesus monkeys kept on a purified diet. For the same daily intake of thiamine, riboflavin, and pyridoxine (about 1 mg/day) there was excreted a greater quantity of riboflavin (about 0.32 mg/day) than of pyridoxine (about 0.025 mg/day) or of thiamine (about 0.17 mg/day). On an intake of 20 to 30 mg/day of niacinamide about 1 mg/day was excreted as N^1 -methylnicotinamide. On a daily ascorbic acid intake of 50 mg only 2 to 3 mg/day of ascorbic acid were found in the urine. The average excretion of pteroylglutamic acid ranged from 0.003 to 0.014 mg/day on an intake of about 0.2 mg/day. Determinations on serum samples revealed average levels of about 197 I.U.% of vitamin A, 6 μg % of carotene (carotene-free diet), and 0.77 mg % of ascorbic acid. With 5% fat in the diet only 2.8 to 8.5% of the ingested fat was lost in the feces. The fecal fat concentration ranged from 6.1 to 13.4% of the dry weight of the feces. Because of the variation in fecal fat loss in an individual monkey from one collection period to another, a long balance period is a more reliable index of fat absorption than a short-time study. (auth)

21978 EXPERIMENTAL STUDIES ON THE EXCRETION AND DISTRIBUTION OF Cs^{137} . VIII. EFFECTS OF STARVATION AND THE ADMINISTRATION OF NUTRIENT SOLUTION. E. Ogawa, S. Suzuki, J. Machida, R. Fukuda, H. Hayashi, and K. Horikawa (Gunma Univ., Maebashi, Japan). *Kitakanto Igaku*, 9: 1104-8 (1959).

Forty-eight hours of starvation after the administration of Cs^{137} caused a decrease in excretion. Retention was not improved by transfusion of Ringer's solution. There was no significant change in starved mice after the transfusion of glucose solution, but they recovered rapidly when food was given. Rb^{86} was used in a similar experiment, with similar results. When a transfusion of Ringer's solution and glucose was given to normal mice, there was no appreciable change in the excretion and body distribution of Cs^{137} . When periston-N (polyvinylpyrrolidone) was given, some increase in retention in the muscles was observed with no change in excretion. (Absts. Japan. Med., 1: No. 7, 1960.)

21979 STUDY ON COBALT-GREENPOLE. II. DISTRIBUTION OF Co^{60} -GREENPOLE IN THE LIVING BODY AND ITS EXCRETION. N. Nakashima (Univ. of Kumamoto, Japan). *Kumamoto Igakkai Zasshi*, 33: 1581-5 (1959).

Intravenously injected Co^{60} -greenpole in the white rats was mostly distributed in the liver, spleen, and bone marrow (with the maximum value at 6 hours after injection), but less in the lung, intestine, and kidney (a maximum value at 3 hours after injection). Histologically and autoradiographically examined, the injected material was dem-

onstrated in the Kupffer cells of the liver, in reticulum cells of the spleen, and in the large phagocytic cells in the alveola of the lung. Excretion with the urine and feces was maximum on the first day after injection and on the fifth day the total amount reached about $\frac{1}{3}$ of the injected dose. (Abstr. Japan. Med., 1: No. 1, 1960)

21980 SERUM CHANGES IN THE RAT FOLLOWING ORAL ADMINISTRATION OF CADMIUM. D. J. Lawford (London Hospital, Eng.). *Nature*, 190: 815 (May 27, 1961).

Sixteen rats were maintained on a regular diet and allowed unlimited drinking water containing 50 ppm of Cd. Severe anemia developed in all animals within 4 weeks. Starch gel electrophoresis patterns of the blood serum showed two abnormalities in the serum protein pattern. (C.H.)

21981 PRESERVATION OF MOUSE BONE MARROW AT -79°C . WITH DIMETHYL SULPHOXIDE. M. J. Ashwood-Smith (National Inst. for Medical Research, London). *Nature*, 190: 1204-5 (June 24, 1961).

Dimethyl sulfoxide was shown to protect mouse bone marrow from the effects of freezing to -79°C . After thawing, the protected cells retained 50 to 60% of their ability to synthesize lipids and proteins. It was also found that mouse bone marrow stored for one month at -79°C in the presence of dimethyl sulfoxide will prevent the death of lethally irradiated mice and is only slightly inferior to fresh marrow. The hematological response of lethally irradiated mice to fresh and preserved marrow was also studied. The leukocyte response of mice that received frozen marrow preserved with dimethyl sulfoxide was slightly better than the response obtained with 1×10^6 fresh cells. Blood leukocyte levels were normal, but the differential counts were abnormal. (P.C.H.)

21982 EXPERIMENTAL STUDY ON URANIUM POISONING. Y. Mizutani (Nagoya Univ., Japan). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 2156-61 (1960).

Rats injected with 0.05 mg/g of soluble uranium (uranyl nitrate hexahydrate) intra-peritoneally all died within 30 hr after the injection. Microscopically moderate hyperaemia and bleeding in the stroma and hyaline degeneration of the epithelial cells of the tubuli were seen in the kidney. In the group injected with less U, the survival time after the injection was increased. These changes seen in rats are considered to result from the chemical toxicity of uranium compounds rather than from radiation energy. In the group injected with 0.001 mg/g of U, renal changes were very slight and almost complete recovery was observed after about 3 weeks. One thousand mg and 300 mg of insoluble U was administered by inhalation into the lungs of adult rabbits. They died in 4 to 7 days after the inhalation. Microscopic examination of the lungs showed moderate to severe lymphocytic and slight leukocytic infiltration with moderate proliferation of the septal cells, mainly around the deposited U dusts. Exudation also was present. Rabbits inhaling 100 mg of insoluble U survived over 4 months. No loss of weight or hematological changes were seen. About 4 months after the inhalation, one of these rabbits was sacrificed and examined microscopically. No severe changes were demonstrated in lungs and kidneys. In the heart muscle of rabbits inhaling 1000 mg of insoluble U, some α tracks were recognized radioautographically, an indication that some of the U dusts might have been taken into the blood stream. (Absts. Japan. Med., 1: No. 7, 1960.)

21983 THE EFFECT OF EXPERIMENTAL RACHITISM ON THE FIXATION OF RADIOSTRONTIUM IN THE SKELETON. (b) STUDY IN RATS AFFECTED WITH RACHITISM IN THE REMISSION PHASE. Ugo Meldolesi and Salvatore

Privitera (Università, Catania, Italy). *Radiobiol. latina*, 3: 331-9 (Oct.-Dec. 1960). (In Italian)

The skeletal fixation of Sr^{89} given intraperitoneally to rachitic rats while the malady was in the quiescent phase was studied. The augmentation of development and mineralization of bone in the animals was accompanied by a modest late increase in the quantity of radiostrontium fixed. By comparison with the results obtained in an earlier investigation of rats actively developing rickets, these alterations in bone metabolism did not result in any increase in radiation damage to the bone marrow—on the contrary, the damage was slightly less. (auth)

21984 THE TRACER STUDIES ON THE DISTRIBUTION AND EXCRETION OF MERCURY BY THE RAT. Eiko Sairenji, Chitoshi Itai, Yukimichi Urata, Toshinori Suzuki, Hiroyoshi Yamano, and Emiko Sasaki (Nihon Univ., Japan). *Radioisotopes* (Tokyo), 9: 33-41 (Apr. 1961). (In Japanese)

Following a single intravenous injection, mercury was distributed rapidly into all organs of the rat within a few hours. In terms of Relative Specific Activity (RSA) the renal level of Hg^{203} was found to be high over the entire period. In the spleen, lungs, muscle, and liver, high values of RSA appeared during the first period, and at a later stage, small intestine, spleen, liver, lungs, skin, and fur were the chief sites of deposition. 50% of the administered dose was found in the muscle followed in order by the kidney, blood, skin, and fur, liver, bone, and small intestine. After one week the dose in these organs decreased, except in the kidney. Hg^{203} was excreted via both feces and urine. The excretion rate was high (70%) for the first few days but decreased. The biological and effective half lives of Hg^{203} were determined to be 50 and 24.2 days, respectively. (P.C.H.)

21985 CONTRIBUTION A L'ETUDE DU MÉTABOLISME CELLULAIRE AU MOYEN DE LA MÉTHODE AUTORADIOGRAPHIQUE. (Contribution to the Study of Cellular Metabolism by Means of Autoradiographic Methods). A. Ficq. Monographie No. 9. Brussels, Institut Inter-universitaire des Sciences Nucleaires, 1961. 145p.

The autoradiographic method with nuclear emulsion is described along with the problems studied. The method was used to confirm the existence of direct intervention of ARN in the synthesis of proteins in normal somatic tissues. The metabolism of nucleic acids and proteins at the time of oogenesis was also studied. The autoradiograph also supplied some data on the role of the nucleus and cytoplasm in the activity of the small cell. In adult tissue, the nucleus of the hepatic small cells is characterized by an elevated metabolic activity. Autoradiography also verified that cytoplasmic contamination does not modify the incorporation of radioactive phenylamino in the proteins of isolated nuclei of the thymus. Observations made on the oocytes (starfish) show that the nucleole presents a more intense metabolic activity than other cellular elements (nuclear substance, cytoplasm). Some tests with thymidine- H^3 , cytidine- H^3 , uridine- H^3 , leucine- H^3 , and lysine- H^3 indicate that a closer relation exists between ARN and the chromosomal proteins than between ADN and chromosomal proteins. (P.C.H.)

Fallout and Ecology

21986 (AEET-AM-19) A STUDY OF WASHOUT OF RADIOACTIVE FALLOUT AND PARTICULATE MATTER IN INDIVIDUAL RAIN SHOWERS. V. V. Shirvaikar, V. S. Bhatnagar and C. Rangarajan (India. Atomic Energy Establishment, Trombay). Nov. 1960. 27p.

A study of the ground deposition of fall-out radioactivity

by rain was made by measuring the radioactive content of successive fractions of rain showers collected during the monsoon rains of 1958 at Bombay. It was observed that the activity deposited in a shower is roughly proportional to the amount of rainfall. The specific activity of rainwater of successive fractions of a shower varied within wide limits. The specific activity of rainwater was found to be independent of precipitation rate in some cases, while in a few other cases an inverse relationship was observed. (auth)

21987 (AEET-AM-21) CESIUM-137 AND STRONTIUM-90 IN MILK. K. G. Vohra, U. C. Mishra, C. W. Joshi, B. Y. Lalit, and A. S. Deshpande (India. Atomic Energy Establishment, Trombay.). Jan. 1961. 29p.

Cs^{137} and Sr^{90} levels in liquid milk samples from Bombay and 27 other stations in India, and powder milk samples from Australia, Denmark, Holland, India, U. K., and U. S. A. were estimated. Cs^{137} levels were estimated using a 10-channel scintillation spectrometer. Sr^{90} levels were measured by chemical separation of Sr^{90} from samples of milk and measurement of beta activity on a low-level beta counting instrument. The average levels of Cs^{137} in Bombay milk were 9.4 uuc/gram of potassium, 18.3 uuc/gram of potassium, and 11.4 uuc/gram of potassium, for the years 1958, 1959, and 1960, respectively. The corresponding levels of Sr^{90} were 2.3 uuc/gram of calcium, 4.9 uuc/gram of calcium, and 2.6 uuc/gram of calcium, respectively, for the same period. The country wide samples show average levels of 1.7 uuc Cs^{137} /gram of potassium and 5.9 uuc Sr^{90} /gram of calcium during the year 1959. In 1960 these levels dropped down to 5.5 uuc Cs^{137} /gram of potassium and 2.3 uuc Sr^{90} /gram of calcium. The maximum and minimum levels of Cs^{137} in India in 1959 were 159.9 and 3.2 uuc/gram of potassium, respectively. The corresponding maximum and minimum levels of Sr^{90} were 32.6 and 0.5 uuc/gram of calcium, respectively. It was further observed that Cs^{137} and Sr^{90} contents in Australian and Indian milk were lowest and of the same order. The concentrations were highest in the sample from U. K. The results of these measurements were interpreted on the basis of the total injection of these isotopes in the atmosphere, their rate of fall-out, and seasonal effects. (auth)

21988 (AEET-AM-22) SEASONAL VARIATIONS OF CESIUM-137 IN THE GROUND LEVEL AIR. A. G. Vohra, V. S. Bhatnagar and C. Rangarajan (India. Atomic Energy Establishment, Trombay). May 1961. 11p.

An increase in the Cs^{137} content of the ground level air was observed at Bombay during the spring seasons of the years 1957 to 1960. A similar increase was observed at seven other stations in India during 1960. The spring maximum of the years 1957 to 1959 can not be attributed to only the "seasonal effects" in the stratospheric fallout because of the testing of nuclear weapons a few months prior to the observed increase during these years. However, the increase during 1960, observed in the months January to April can be due to the "seasonal effects" because there were no tests carried out in 1959. The increase in 1960 due to the French Atomic Tests in February and April is expected to make only a small contribution to Cs^{137} in the air. The ratios of Cs^{137} to gross beta activity were also studied and these supported the general conclusions. (auth)

21989 (CEA-1854) UTILISATION DES VEGETAUX LIGNEUX AU CONTROLE DE LA POLLUTION RADIOACTIVE D'UN SOL. (The Use of Ligneous Plants for Controlling the Radioactive Contamination of a Soil). J. Gagnaire

(France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1961. 32p.

A method for control of the possible radioactive pollution of CEN-G. soil is described. Samples were taken of tissue of ligneous plants cultivated on the land in question during the vegetation period. A preliminary study on the retention capacity of the CEN-G. soil for solutions containing P^{32} and of variable chemical composition is described. (auth)

21990 (UCLA-475) INFLUENCE OF CHELATES ON THE AVAILABILITY OF FISSION PRODUCTS TO PLANTS GROWN IN A CONTAMINATED SOIL. E. Essington, H. Nishita, and A. Wallace (California. Univ., Los Angeles. School of Medicine). June 5, 1961. Contract AT(04-1)-GEN-12. 26p.

The effects of chelates such as ethylenediaminetetraacetic acid (EDTA), hydroxyethylenediaminetetraacetic acid (HEEDTA), cyclohexane-1,2,-diaminetetraacetic acid (CDTA), diethylenetriaminepentaacetic acid (DTPA), ethylenediamine di-o-hydroxyphenylacetic acid (EDDHA), and an analog of EDDHA, Ra-156, on the uptake of Y^{91} , Sr^{90} , Zn^{65} , and Cs^{137} by bean plants grown in a contaminated calcareous soil were investigated. The plant uptake of Sr^{90} and Cs^{137} was unaltered by chelate applications to the contaminated soil. Most of the chelates increased the plant uptake of Y^{91} and Zn^{65} . DTPA and H-CDTA had the greatest effect in increasing the uptake of Y^{91} and Zn^{65} . EDDHA and Ra-156 had no effect on Y^{91} uptake. Na-EDDHA decreased Zn^{65} uptake. Leaf to root ratios for Y^{91} and Zn^{65} indicated that chelates increased the translocation of Y^{91} and Zn^{65} to the leaves from the roots. Part of the ineffectiveness of EDDHA and Ra-156 appeared to be their low chelation power at the pH level of the soil, which was 7.8. (auth)

Radiation Effects on Living Tissues

21991 (AD-251574) INVESTIGATION OF RELATIVE MICROBIOLOGICAL RESPONSE TO VARYING TYPES AND METHODS OF APPLICATION OF IONIZING RADIATION. Report No. 1 (Progress), December 1, 1959-February 29, 1960. Lloyd L. Kempe (Michigan. Univ., Ann Arbor. Research Inst.). Contract DA-19-129-qm-1532. 6p. (UMRI-03570-1-P).

No significant difference was observed between the lethality of gamma radiation from cobalt-60 for Clostridium botulinum 62A spores when the radiation was delivered intermittently or continuously. Studies on the effect of intensity of the irradiation field on the lethality of gamma radiation for spores of C. botulinum are in progress. (auth)

21992 (AD-251633) COMPARATIVE RESISTANCE OF STRAINS OF CLOSTRIDIUM BOTULINUM TO IONIZING RADIATION. Report No. 7 (Progress), December 11, 1959-March 10, 1960. J. M. Heinen (Continental Can Co., Inc., Chicago). Contract DA-19-129-QM-1214. 8p.

Spore suspensions of six strains each of Type-A and Type-B, and three strains of Type-E Cl. botulinum were prepared and standardized. Inocula of 100 million spores per can (202 x 202) of a beef stew substrate were exposed to various levels of gamma rays to produce partial spoilage. From the partial spoilage data, radiation D values for 90% destruction are calculated as a measure of radiation resistance. The data previously reported for the Iwanai Type-E strain were withdrawn as invalid and results are summarized for VH, Beluga, and 8E strains. The data now show all Type-E strains lower than the lowest Type-B strain. Procedures are being developed for spore production of Type-C strains. However, sporulation ability ap-

pears to vary from strain to strain, as well as the potential viability of the strains. These factors are currently under investigation. (auth)

21993 (AD-251706) STUDIES OF THE IMMUNOLOGICAL FACTORS INVOLVED IN HOMOLOGOUS TISSUE TRANSPLANTATION. Progress Report, March 1, 1960 to February 28, 1961. William D. Holden (Western Reserve Univ., Cleveland. School of Medicine). Contract DA-49-007-MD-961. 29p.

Irradiation of canine renal homografts with an average dose of 770 r delivered locally, failed to prolong the functional survival as compared with controls. Split thickness skin homografts placed on dogs rejecting a renal homograft placed in the portal circulation, rejected as second-set grafts indicating that the liver did not effectively modify tissue antigens supplied to it. Canine renal homografts placed in dogs following rejection of split thickness skin homografts ceased functioning in an average of 4.5 days, some 50% more rapidly than control grafts not preceded by skin homografts. In these experiments the evidence seems clear that both skin and kidney tissues have the ability to sensitize recipient animals and allow second set rejection to take place. In a large series of animals, it was not shown that 12 mg/kg of 6-mercaptopurine given intravenously daily prolonged skin homografts in rabbits, or indeed in any other animal used in the laboratory. In continuation of the screening program, several additional drugs were studied, none of which appear to favorably prolong the life of skin homografts. One human renal homograft was transplanted which functioned in progressive fashion for the life of the patient. Bone was treated to determine the effect of treatment on antigenicity. S^{35} -ethyl-1-cysteine can be incorporated unchanged in the rabbit antibody molecule and into the proteins of an E. Coli mutant. It is apparently metabolized by the wild-type E. Coli and the label is found in the cysteine fraction. The substance arising in lymph nodes as a result of a skin homograft and which, when intradermally injected, causes a cutaneous reaction, was obtained in its active form in a cell-free preparation. Experiments are in progress to localize intracellular antibody on sub-cellular structures using labelled antigens. Antibody of a circulating type is being compared with that of a non-circulating type in this context. The influence of 6-mercaptopurine on immunity was studied in guinea pigs. Three types of immune reactions were examined, viz., the homograft reaction and the delayed and immediate types of immunity evoked by footpad injection of specific precipitates in adjuvant. The following were observed: 6-MP had no influence on skin grafts; under conditions of high levels of immunity it could partially inhibit an Arthus-type skin reaction; only in toxic animals could the delayed skin reaction be inhibited; and the immediate skin reactions failed to reflect the circulating antibody level which, in turn, was not affected by the drug. The data are discussed and tentative conclusions are drawn. The ability of the treated guinea pig to form antibody is believed to be essentially unimpaired, but manifestations of immunity requiring the intervention of reticulo-endothelial cells reflect the action of the drug. (auth)

21994 (BNL-5441) THE LONG TERM SOMATIC EFFECT OF RADIATION WITH EMPHASIS ON LEUKEMIA. Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). [1961]. 16p.

Data on the relationship of leukemia to prior exposure to radiation are discussed. Studies of leukemia in survivors of the atomic bombs showed that the modal time of onset is

approximately 5 yr. It was also estimated that 90% of the process would be over within about 10 yr of the time of exposure. A study of the cases reported showed that more cases were observed in 1951 and 1952 and after that the number of cases decreased each year. The Japanese data and experiments with animals indicated that a constant incidence of leukemia throughout the remaining life will not be induced by radiation. Leukemia was also studied in patients treated for Ankylosing Spondylitis, following pelvic diagnostic x rays in pregnancy, following thymic irradiation in infancy, and following occupational exposures. The best yield estimate was found to be approximately 1 to 2 cases per 10^6 population at risk per year per rad exposure following short term doses in excess of 100 rads. (M.C.G.)

21995 (DASA-1179) TEMPERATURE HISTORIES ASSOCIATED WITH THERMAL RADIATION BURNS TO HUMAN SKIN. Lab. Project 5046-16, Part 8 Final Report. W. L. Derksen, T. I. Monahan, and G. P. deLhery (Naval Material Lab., Brooklyn). Jan. 15, 1960. 17p.

The temperature histories associated with burns to human skin were derived from radiant exposures to cause burns to animals under several test conditions and some on human skin. Sub-burn temperature measurements were employed to compute the equivalent radiant exposures required to burn human skin. The temperature histories for the surface and at a depth of 0.05 cm were obtained by exposing a skin simulant to the equivalent radiant exposures calculated for human skin. It was found that temperatures of 60 to 100°C near the surface need be exceeded for only one or two seconds. Temperatures of 50 to 60°C were exceeded for 5 to 10 sec. (auth)

21996 (ORO-412) THE EFFECT OF IONIZING RADIATIONS ON GEOTROPIC RESPONSE OF PLANTS. Terminal Report. Arthur L. Koch (Florida. Univ., Gainesville). [1960]. Contract AT(40-1)-2566. 43p.

The recovery of geotropism in irradiated tissues was studied for corn, pea seeds, and snapdragon inflorescences. The relationship of radiation effects on growth to those on geotropic response was examined. Radiation effects during the geotropic lag period was also studied. Reversal of radiation inhibition by growth regulators was found to be possible in pea seeds. Transport of auxin in mature corn stem pieces was studied as a function of orientation with respect to gravity. (D.L.C.)

21997 (JPRS-3398(p.55-60)) THE CHARACTERISTICS OF PROTEIN SYNTHESIS IN THE ORGANOIDS OF CELLS IN THE TISSUES OF NORMAL AND IRRADIATED WHITE RATS. L. I. Il'ina and R. V. Petrov. Translated from *Tsitologiya*, 1: 289-92(1959).

The ratio of S^{35} -methionine to C^{14} -tyrosine in the proteins of cells in the liver and the mucous membrane of the small intestine of normal rats is characterized by values of 1.6 to 3.5. This ratio underwent practically no change in the nuclei, mitochondria, and hyaloplasm of the cells of the above-described tissues in white rats which had radiation sickness. The ratio of S^{35} -methionine to C^{14} -tyrosine in the summed proteins of the microsomes of the cells of both types of tissue changed sharply with radiation sickness. In irradiated rats it was characterized by values of 0.7 in the liver and 0.9 in the mucous membrane of the small intestine. (auth)

21998 (JPRS-3398(p.60-78)) MATERIALS FOR DESCRIBING THE EFFECT OF IONIZING RADIATION ON INDIVIDUAL DEVELOPMENT. Yu. M. Olenov, K. F. Galkovskaya, and A. D. Pushnitsyna. Translated from *Tsitologiya*, 1: 293-305(1959).

Roentgen exposure of larvae and pupae of Drosophila melanogaster causes the destruction of part of the cells of the imaginal disks, the rudiments of definite organs of the insect. X-ray mutations are the result of the incomplete repair of this injury. Their frequency depends upon the time of repair. The data obtained permit one to give a new interpretation of the concept of the sensitive period in ontogenesis. The stage for which the repair process caused by the inflicted injury coincides with sensitive period for a given indication, for a given external influence. The destruction of part of the undifferentiated cells and the deviations caused by it in the further course of ontogenesis are obviously a general characterization of the effect of ionizing radiation on the developing organism. One should have this picture in mind when working out a theory of the biological action of ionizing radiation. (auth)

21999 (JPRS-3398(p.79-94)) REVERSIBILITY OF DIFFERENT FORMS OF RADIATION INJURY IN DIPLOID YEAST CELLS. V. I. Korogodin, O. V. Malinovskii (Malinovskiy), N. A. Poryadkova, and N. A. Izmozherov. Translated from *Tsitologiya*, 1: 306-15(1959).

Proof is presented of the existence of the restoration effect in diploid yeast cells irradiated by gamma-rays when they are incubated in a nonnutrient medium after irradiation. It is shown that postradiational mitotic dormancy is accompanied by a decrease in the biological consequences, of irradiation connected with cumulative effects, local effects, and mixed effects on the cells. A working hypothesis is used to explain the effect of restoration. According to this hypothesis, the primary radiobiological injuries can have a potential form and a reversible character. The probability of their transformation into irreversible changes is in inverse proportion to the duration of post-radiational mitotic dormancy and is connected with the physiological state of the cells and the physicochemical conditions of the medium. (auth)

22000 (JPRS-3398(p.95-102)) THE EFFECT OF GAMMA-RAYS ON MITOSIS IN A POLYPLOIDIC SERIES OF WHEAT. N. A. Izmozherov. Translated from *Tsitologiya*, 1: 316-19(1959).

The effect of gamma-rays on mitosis in a polyploid wheat was studied. Dry seeds were irradiated with a dose of 11,000 roentgens. The rootlets were fixed 48 hours after germination. The results of cytological analysis showed that the mitotic activity had declined about the same extent in all species of wheat, that is, it did not depend upon the degree of ploidy. The number of abnormal anaphases increased with an increase in ploidy. The quantity of chromosome bridges per 100 anaphases increased with increased ploidy, but the number of fragments remained constant for the different species of wheat. One can conclude from this that the effect of gamma-rays on the rate of cell division and on the occurrence of abnormal mitosis is not a single process. (auth)

22001 (JPRS-3398(p.103-7)) RADIOSENSITIVITY OF THE MERISTEM OF BUDS AND RADICLES IN THE GERMS OF PEAS AND BARLEY. V. V. Khvostova and N. L. Delone. Translated from *Tsitologiya*, 1: 320-2(1959).

It was discovered through cytological analysis of the tissues of the radicles and shoots in sprouts of peas and barley produced from seeds which had been irradiated with gamma-rays that there was a large percentage of cells with chromosome rearrangements in those tissues whose growth had been most retarded. Consequently, the radiosensitivity of tissues is linked with greater vulnerability of cellular nuclei. (auth)

22002 EFFECT OF X RAYS OF POLIOMYELITIS VIRUS. Nicoló Ercoli (Istituto Venezolano de Investigaciones Científicas (Venezuela)). *Acta Cient. Venezolana*, 12: No. 1, 15-17 (Feb. 1961). (In Spanish)

The effect of x radiation on the virulency of the Lansing strain of polio virus (type II) was studied. The virulency of a suspension with a concentration of 10^{-4} in the cerebrum and spinal column of mice decreases only with a radiation dose of 200,000 r, and in a suspension of 10^{-6} with a dose of 100,000 r. The Lansing strain studied compared with the rabbit papilloma virus (3000 r) and the fibroma virus (10000 r) and with the susceptibility to ultraviolet rays shows a well defined resistance to x radiation. Very probably this resistance depends on the small size of the virus as well as on the presence of foreign proteins which influence the primary and secondary effects of ionizing radiation. (tr-auth)

22003 EFFECTS OF IONIZING RADIATION ON THE POTASSIUM, SODIUM, AND WATER CONTENTS OF RAT LIVERS AND THEIR CELLULAR FRACTIONS. Francesco Bresciani and Ferdinando Auricchio (Università, Naples). *Atti. acad. nazl. Lincei. Rend., Classe sci. fis., mat. e nat.*, 29: 431-7 (Nov. 1960). (In Italian)

The liver of rats was exposed to 35 kr of x radiation and the potassium, sodium, and water concentrations in the flesh, mitochondria, nuclei, and cellular fractions were determined. The results are tabulated and compared with values obtained with non-irradiated animals. The total water in the tissues increases, but is reduced in the nuclei and mitochondria. The molar sum of Na and K compared with the water of the fractions appears reduced in the tissue and mitochondria but increased in the nuclei. The ratio K/Na is consistently lower. Possible hypotheses to explain these results are discussed. (J.S.R.)

22004 ON THE ACTIVITY OF INTRACELLULAR DNASE OF *ESCHERICHIA COLI* B AFTER X-IRRADIATION. E. Kos and M. Drakulic (Inst. "Rudjer Boskovic," Zagreb). *Biochem. Biophys. Research Commun.*, 5: 152-5 (June 2, 1961).

No significant differences were found between the desoxyribonuclease activity in irradiated and unirradiated *Escherichia coli* cells. Possible reaction mechanisms involved in the degradation of desoxyribonucleic acid in *Escherichia coli* are discussed. (C.H.)

22005 STUDIES ON RADIOSENSITIVITY OF RATS FOR Co^{60} -IRRADIATION. II. EFFECT OF CYSTEINE INJECTION ON RADIOSENSITIVITY. S. Kitaoka (Kyoto Univ.). *Haseibutsu*, 2: 557-63 (1959).

Rats of Wistar strain were irradiated by γ rays of Co^{60} (7000, 6000, 5000 r), following intraperitoneal injection of cysteine. There were some individual variations in the radiosensitivity effect of cysteine. In the group of cysteine injection the survival rate and LD_{50} appeared to be larger than in the control animals. The increasing rate of the body weight in the cysteine-injected animals was greater than in the controls. Rats irradiated with 1000 r after the injection of cysteine showed less leukopenia compared with the animals irradiated without the injection. From these results, the injection of cysteine seems to be effective for protection of radiation disease. (Absts. Japan. Med., 1: No. 7, 1960.)

22006 HEMATOLOGIC FINDINGS IN CHILDREN EXPOSED TO A-BOMB RADIATION IN UTERO IN HIROSHIMA. Tsugiso Takamura and Shoichi Ueda (Atomic Bomb Casualty Commission, Hiroshima). *Blood*, 17: 728-37 (June 1961).

Hematologic findings in in utero atomic bomb irradiated and nonirradiated children of Hiroshima between the years 1950 to 1957 were compared. No changes peculiar to the irradiated group were found. Overt anemia cases were rare, and distribution of hemoglobin levels was only slightly lower than those reported in American and European children. Leukocyte levels, irrespective of age of the children, were found to be progressively falling in the children of Hiroshima, whether or not exposure to irradiation had occurred. By 1957 the values were distinctly lower than those reported for normal children in Japan and the U. S. No cause for this change was apparent. (auth)

22007 POLYPOIDY AND RADIOSENSITIVE BEHAVIOUR OF HUMAN MALIGNANT CELLS *IN VIVO*. N. De (Chittaranjan National Cancer Research Centre, Calcutta). *Brit. J. Cancer*, 15: 54-60 (Mar. 1961).

A correlation between radiosensitive and polyploid behaviors of malignant cells *in vivo* was assessed in twenty cases of epidermoid carcinomata of the human cervix uteri. It has been observed that in the majority of the cases (75%), there is a correlation between higher ploidy (more than sixty chromosomes) of malignant cells and their radioresistant character. There is also a direct relationship in the majority of cases (83%) between lower ploidy (less than sixty chromosomes) of malignant cells with their radiosensitive behavior. (auth)

22008 EFFECT OF HIGH PRESSURE OXYGEN ON RADIOSENSITIVITY OF EHRLICH'S TUMOUR IN MICE AFTER "IMMUNOLOGICAL APPROXIMATION." H. A. S. Van Den Brenk (Cancer Inst. Board, Melbourne). *Brit. J. Cancer*, 15: 61-84 (Mar. 1961).

The effect of breathing high pressure oxygen (OHP) at 45 lb per square inch gauge pressure on radiosensitivity of Ehrlich's tumor (solid form) *in vivo* was studied. Recipient mice were given 400 r whole body irradiation before inoculation of tumor cells to cause immunological approximation and a substantial reduction in the homograft reaction. The effect of irradiation was based on cure of tumors 8 weeks after irradiation. Regression curves show that OHP caused a significant increase in radiosensitivity (radiocurability) with a dosage reduction by a factor of 2.4 (± 0.5 SE). Tissue reactions assessed 4 weeks after irradiation were increased in OHP by factors ranging from 1.6 to 2.2. Evidence is provided that in mice breathing air at atmospheric pressure, tissue radiosensitivity approached levels corresponding to minimum (anaerobic) values. The results of polarographic measurements of oxygen tension in normal tissues and tumors in animals breathing air and OHP are described and discussed. (auth)

22009 FOETAL MALFORMATION IN A TECHNICIAN AT A CLINICAL RADIOISOTOPE LABORATORY. Erling Hammer-Jacobsen and Troels Munkner (University Hospital, Copenhagen). *Brit. J. Radiol.*, 34: 351-5 (June 1961).

A 24-year-old technician at a diagnostic radioisotope laboratory had an abortion in her fifth month of pregnancy. The foetus was anencephalic and has various other malformations, inter alia bilateral radius aplasia. It is concluded that the malformations can hardly be caused by the radiation exposure at the laboratory (estimated foetal dose 0.03 r). (auth)

22010 THE EFFECT OF RADIATION ON THE NORMAL AND OESTRONE-TREATED MOUSE VAGINA GROWN IN VITRO. Ilse Lasnitzki (Strangeways Research Lab., Cambridge, Eng.). *Brit. J. Radiol.*, 34: 356-61 (June 1961).

The effect of radiation on the differentiation of normal

and oestrone-treated organ cultures of the mouse vagina was studied during growth in natural and in chemically defined medium. After explantation into either type of medium without addition of the hormone the vaginal epithelium spontaneously forms new squamous keratinising epithelium which displaces the original secretory epithelium. Addition of oestrone to the medium stimulates the growth of the new cells and hastens and increases keratin synthesis. Exposure to 300 r of x rays given one day after explantation inhibits the squamous development, suppresses keratin formation and preserves the original epithelium in both normal and oestrone-treated explants grown in natural medium. Radiation of cultures kept in defined medium fails to influence the normal squamous differentiation and keratinisation. The mechanism of radiation action is discussed in the light of the different results obtained under the two conditions. (auth)

22011 RADIOLOGICAL CHANGES IN ALVIAN OSTEO-PETROSIS. J. R. Holmes (Univ. of Bristol, Eng.). *Brit. J. Radiol.*, 34: 368-77 (June 1961).

The radiological changes observed in 108 cases of experimentally induced avian osteopetrosis are described. The distribution of lesions in the skeleton and the age at which changes first appear in different bones is reported. It is considered that the radiological changes in the long bones may be divided into four groups. Generally the changes which develop in other parts of the skeleton resemble those in the long bones. Although 20 per cent of the birds also had soft tissue tumours it is considered unlikely that these influenced the development or type of bone lesions produced by this viral agent. The initial reaction of the long bone periosteum represents a characteristic response to any stimulus, the radiological changes in the bird are compared with certain human bone diseases which show, in some stage of their development, a somewhat similar radiological picture. (auth)

22012 STUDIES ON RADIOSENSITIVITY AND BIOLOGICAL PROPERTIES OF TWO TUMOUR TYPES INDIGENOUS TO THE SAME HOST. III. THE INFLUENCE OF THE "TIME INTENSITY FACTOR" ON GROWTH OF TUMOURS. Anna Goldfeder and Grace E. Clarke (New York Univ., New York). *Brit. J. Radiol.*, 34: 446-53 (July 1961).

The response of two types of mouse mammary tumor (spindle cell type, faster growing, DBAG, and epithelial type, slower growing, DBAH, both indigenous to the same host) to a dose of 3,000 r applied at 765 r/minute or 7.88 r/minute (ratio 97:1) was investigated. A significantly greater effect was exerted when both types of tumor were irradiated at low intensity. The greater effect is demonstrated not only by the relatively greater decrease in the growth rate of the treated tumors, but also by total regression of several of the faster growing DBAG tumors, a result which failed to occur among the tumors irradiated at the high intensity. The dose-rate effect is manifest to a lesser degree in the epithelial type DBAH tumor treated at the low intensity in that no total regressions occurred. (auth)

22013 EFFECT OF SPACED X-RAY DOSE FRACTIONS ON P^{32} UPTAKE BY THE MOUSE KNEE JOINT. DEPENDENCE UPON SIZE OF FRACTIONS AND THEIR SPACING INTERVALS. C. W. Wilson (Westminster Hospital, London). *Brit. J. Radiol.*, 34: 454-7 (July 1961).

Using the depression of uptake of P^{32} in the mouse knee joint as the biological indicator of radiation effect, the effect produced by a single, 2000 r x-ray dose was compared with that produced by the same total dose given in

two fractions, 1500 r + 500 r, 1000 r + 1000 r, and 500 r + 1500 r, and also given in four 500 r fractions delivered daily. It was found that four 500 r daily fractions produced the smallest effect of all. Of the two-fraction doses the least effect was produced by two 1000 r fractions, while the effects produced by the other two-fraction doses fell between that produced by two 1000 r fractions and that (maximum) effect produced by a single dose of 2000 r. The results illustrate how radiation energy may be wasted by various dose fractionation schemes and show, for this particular biological effect, which methods may be the most wasteful. (auth)

22014 DOSE AND DOSE RATE EFFECTS OF X-IRRADIATION ON PLANTS WITH VARYING CHROMOSOME NUMBERS. Gordon M. Clark, D. G. Baker, and J. Heddle (Univ. of Toronto). *Can. J. Genet. Cytol.*, 1: 142-6 (Nov. 1959).

With 4 day germination as the criterion of radiation effect, diploid buckwheat seeds showed practically no variation with doses of x radiation up to 55 Kr; tetraploid seeds showed a trend toward decreasing germination with increasing dose. The diploid seeds showed a greater dose rate effect. Using the numbers of plants surviving 40 days as the criterion of radiation injury, both the 2n and 4n plants showed a decreased survival with increasing dose. The 4n seeds however had a greatly increased tolerance to radiation injury. (auth)

22015 INCREASED YIELD IN ADVANCED GENERATIONS AFTER X-IRRADIATION OF PISUM. Felicitas Svejda (Canada Department of Agriculture, Ottawa). *Can. J. Genet. Cytol.*, 3: 195-203 (June 1961).

Yield tests carried out during 3 years at Ottawa showed that the average yield of the X_3 and X_4 derived from x irradiation of presoaked 'Chancellor' pea seeds was significantly higher than that of the control. Two bulked samples of the X_3 were tested in 1958 at 10 locations across Canada. The average yield of these bulks was about 10% higher than the yield of the original variety. The increase of the average yield was the result of a large number of higher yielding types in the population from x-irradiated seed. No direct relationship was found between yield and dose levels of x irradiation with 2500r, 5000r, and 10000r. The average yield of the X_3 originating from seed treated with 10000r was lower than from seed treated with 2500r, but higher than from seed treated with 5000r. (auth)

22016 STUDY OF THE SPONTANEOUS ACTIVITY OF CEREBRAL NEUTONS EXPOSED TO A LOCAL IRRADIATION BY X-RAYS. J. Schlag, M. -L. Beaumariage, and J. Guillaume (Université, Liège). *Compt. rend. soc. biol.*, 154: 2132-4 (1960). (In French)

The effect of x radiation localized on the cerebral cortex and on the entire head on the spontaneous activity of cerebral neurons was studied in cats. No modification of the spontaneous activity of locally irradiated cortical cells (dose of the order of 160 r) nor of mesencephalic cells after total irradiation of the brain (dose of the order of 14000 r) was observed. (J.S.R.)

22017 HISTAMINE CONTENT OF THE SKIN OF THE MOUSE AND IRRADIATION BY X RAYS. Marie-Louise Beaumariage (Université, Liège). *Compt. rend. soc. biol.*, 154: 2135-8 (1960). (In French)

The effect of x radiation on the histamine content of mouse skin, irradiated *in toto* at the age of 8 days, was studied. Although wide variations were found in the histamine content of the skin at various sites, doses of 550 and 700 r did not affect the histamine content at the same areas. (J.S.R.)

22018 THE EFFECT OF ULTRAVIOLET RADIATION ON SUCCINIC DEHYDROGENASE ACTIVITY DURING DIFFERENT STAGES OF CELL DIVISION. W. D. Sullivan and J. T. Sparks (Boston Coll.). Exptl. Cell Research, 23: 436-42 (Apr. 1961). (In English)

Tetrahymena pyriformis GL was grown in a chemically defined medium. Synchronous division was induced by the temperature flux method. The succinic dehydrogenase activity was tested in both control and irradiated cultures of each stage of division. The enzymatic activity of those control organisms tested immediately after shock treatment and those tested 150 minutes after shock treatment was inhibited when compared to the normal control. In the same two stages ultraviolet radiation caused a significant acceleration of activity. It is concluded that this acceleration of enzymatic activity may be the result of an attempt on the part of the organisms to recover from the lethal effects of radiation. (auth)

22019 INFLUENCE OF X-RAY IRRADIATION AND STREPTOMYCIN ADMINISTRATION ON EXPERIMENTAL TUBERCULOUS LESIONS. H. Komatsuda (Kyushu Univ., Fukuoka). Fukuoka-Igaku-Zasshi, 50: 2501-22 (1959).

Experimental tuberculous lesions were produced by a separate inoculation of *Mycobacterium tuberculosis* var. bovis and var. hominis in the subcutaneous tissue of the rabbit's back. Then a single x-ray dose of 1,000 r or an injection of streptomycin was administered. The course of these lesions was examined macroscopically and microscopically. When irradiated, repair of the lesions was poor, with thickened outer membranous layer and increased cell infiltration. Bilateral irradiation had a more unfavorable effect than single irradiation. The group treated with streptomycin had a better outcome. (Abstr. Japan. Med., 1: No. 1, 1960)

22020 EXPERIMENTAL STUDIES ON THE COMBINED USE OF PROTECTIVE DRUGS AGAINST RADIATION INJURIES. N. Kota (Kyushu Univ., Fukuoka). Fukuoka-Igaku-Zasshi, 50: 4498-4520 (1959).

When DL-cis-2-aminocyclohexantol (ACT), vitamin K, merthio B₁₂, adrenochrome (AC-17), and neominophagen C were used after a whole-body single dose of 700 r, survival time was lengthened. A slight recovery from bony growth disturbance produced by 1000 r in young rats was observed after vitamin K and merthio B₁₂ used alone, but AC-17 was not effective. ACT plus vitamin K and ACT plus merthio B₁₂ were effective; however, the combined use of ACT and AC-17 was not as effective as AC-17 alone. The radiation-protective action was generally seen near the lethal dose of each agent. If less than the effective dose was administered, the effect was usually unfavorable, and no combined effect was demonstrable. (Absts. Japan. Med., 1: No. 7, 1960.)

22021 THE RELATION OF RADIATION INJURY TO NUTRITION IN MICE SUBMITTED TO WHOLE-BODY LD₅₀ X-RAY IRRADIATION. T. Hata (Kyushu Univ., Fukuoka). Fukuoka-Igaku-Zasshi, 51: 76-102 (1960).

The relation of radiation injury to the qualitative and quantitative changes of nutrition was studied in mice. From the qualitative standpoint of nutrition, the high protein, high casein, and butter diet showed a degree of radiation protection in the changes of the peripheral blood, changes of body weight, and survival rate. The carbohydrate diet showed some effect in radiation protection and recovery. Quantitatively a low caloric diet was conducive to radiation injury and the high caloric diet showed protection and recovery effects in changes of the peripheral blood and body weight which is proportional to the number of

calories. The decrease of caloric intake after irradiation showed an undesirable effect on recovery. (Absts. Japan. Med., 1: No. 7, 1960.)

22022 EFFECT OF AC-17 ON THE 'BLOOD SPECTRUM' OF PATIENTS DURING RADIATION THERAPY. S. Yamamoto, A. Kobayashi, I. Higashi, and S. Kaneishi (Yamaguchi Prefectural Hospital, Japan). Gan no Rinsho, 5: 278-83 (1959).

A hematological and biochemical study of 31 patients with pelvic malignancy during radiation therapy is described. AC-17 was administered intravenously daily after x irradiation. The so-called blood spectrum includes hemoglobin, serum protein, A/G ratio, albumin, globulin, cholinesterase, NPN, urea N, alkali phosphatase, cholesterol, and inorganic phosphorus. This was usually appreciably influenced by x irradiation. However, when AC-17 was used, the blood spectrum was definitely better, especially in the group given over 600 mg of AC-17. The authors believe that AC-17 may be an effective agent against radiation injury. (Abstr. Japan. Med., 1: No. 1, 1960)

22023 Sr⁹⁰ β -IRRADIATION. III. OCULAR DAMAGE PRODUCED BY Sr⁹⁰ β -RAY IRRADIATION. Y. Uemura (Keio Univ., Tokyo). Ganka Rinsho Iho, 52: 538 (1958).

Rabbit corneas were irradiated with larger doses of β rays than the minimum prescribed in the use of Ledermann's ophthalmic Sr⁹⁰ applicator SIA type 3. After an incubation period, inflammatory opacity and edema of the corneas were observed, followed by vascularization, vesicle formation, ulceration, necrosis, and perforation. With irradiation of not more than 54000 r for 360 min, the opacity was absorbed leaving a slight corneal scar, but with irradiation of over 36000 r for 420 min, severe damage, including perforation, occurred in the majority of cases. Individual differences were observed in sensitivity to β rays, even in normal corneas. No abnormality of the lens was observed. At the same time as, or before, the appearance of keratitis, various signs of inflammation were present in the iris and conjunctiva. In an extreme case, hemorrhage was observed, but it disappeared as time progressed. (Abstr. Japan Med., 1: No. 8, 1961)

22024 DISTURBANCES OF SPERMATOGENESIS DUE TO RADIATION BY ATOMIC BOMB EXPLOSION AND FALL-OUT IN HIROSHIMA AND BIKINI. N. Murakami (Tokyo Univ.). Geka no Ryoiki, 7: 1070-83 (1959).

Fifteen persons exposed to the atomic bomb in Hiroshima and 18 exposed to fall-out contamination in the Bikini area were examined for spermatogenesis. Three of the 15 Hiroshima cases showed aspermia and were believed not to have recovered, but all of the 18 Bikini cases showed complete recovery of spermatogenesis. Most of the Bikini cases recovered in 9 to 20 months, but those which received 500 to 600 r of radiation took 30 months to recover. The physico-chemical character of the sperm showed no great change in any of the cases. The function of the prostate was normal. (Abstr. Japan Med., 1: No. 2, 1960)

22025 THE LETHAL EFFECT OF RADIATION. Y. Uda and K. Ono (Hiroshima Univ.). Hiroshima Igaku, 7: 537-41 (1959).

In mice the lethal effect was greatest following irradiation of the upper abdomen. Partial exposure of the head to over 2,000 r also caused the lethal effect. Exposure of the head to 3,000 r appeared to cause death within 3 days. The pathological findings were approximately the same as those seen after whole-body irradiation of the same dose. (Abstr. Japan. Med., 1: No. 1, 1960)

22026 INFLUENCE OF RADIATION ON BODY WEIGHT. Y. Uda and M. Akamatsu (Hiroshima Univ.). Hiroshima Igaku, 7: 557-65(1959).

Mice of the d-d strain exposed to x rays of 300 r to 3,000 r were weighed. This method seems to be just as useful as the LD_{50/30} method for determining biological effects of irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22027 STUDY ON THE EXCRETION OF P³² INJECTED SUBCUTANEOUSLY. III. INFLUENCE OF X-IRRADIATION OF THE WHOLE BODY. M. Date (Hiroshima Univ.). Hiroshima Igaku, 7: 2621-8(1959).

After whole-body irradiation, P³² was injected into the subcutis of mice. In groups given 30 r and 60 r irradiation, the uptake rate of P³² by the tissue was relatively high immediately after irradiation, and may be due to a so-called irradiation shock. In the animals irradiated by 100 r, no such effect resulted. After that the uptake rate was gradually increased approximately in parallel with an increase of histiocytes in the connective tissue. The excretion of P³² showed a maximum level after 5 days in the 100 r irradiation group. This was quite similar to the uptake rate described above. The excretion of P³² from the subcutis directly through the blood stream appeared rather decreased compared with the control. (Abstr. Japan. Med., 1: No. 7, 1960.)

22028 HAEMATOLOGICAL FINDINGS IN WOMEN EXPOSED TO THE ATOMIC BOMB IN HIROSHIMA. IV. CONCLUSION. K. Kinutani (Hiroshima Univ.). Hiroshima Igaku, 12: 716-24(1959).

During the years 1954 to 1956, 1,940 women who had been exposed to the atomic bomb in Hiroshima were examined with special reference to the hematological picture. The hematological findings were generally normal. The abnormal blood findings were considered to be due more to poor living conditions than to radiation effects alone. Therefore, in treating A-bomb survivors, it is considered necessary not only to conduct detailed examinations but also to clarify their A-bomb exposure history and their social history in order to understand their real life situation and thus provide adequate medical care and at the same time social welfare. (Abstr. Japan. Med., 1: No. 1, 1960)

22029 EFFECTS OF CHEMICAL AGENTS ON THE PERIPHERAL BLOOD PICTURES OF RABBITS TREATED WITH P³². R. Imada (Kyushu Univ., Fukuoka). Hiroshima Igaku, 12: No. 6, 21-51(1959).

The effects of chemical agents against the changes induced by P³² injection in the peripheral blood pictures were studied. DL-cis-2-Aminocyclohexanethiol-HCl, DL-trans-2-aminocyclohexanethiol-HCl, and vitamin K were moderately effective. AC-17, cobalt-greenpole, and panilitin were slightly effective. BAL, methionine, gronsan (gluconic acid), and aminoethylisothiuronium-bromide-HBr were less effective. (Abstr. Japan. Med., 1: No. 1, 1960)

22030 EFFECT OF WHOLE-BODY X-IRRADIATION ON THE CHICK GROWTH. T. Kashiwabara, R. Tanaka, and K. Iida (Ibaraki Univ., Japan). Ibaraki Daigaku Nôgakubu Gakujitsu Hôkoku, [No.] 5, 127-31(1957).

White Leghorn male chickens were irradiated by whole-body x-radiation of 10 to 40 r. The body weight appeared more increased in the treated group than in the controls, contrary to the expectations in radiation biology. (Abstr. Japan Med., 1: No. 8, 1961)

22031 THE CHANGES OF GERM CELLS IN X-RAY IRRADIATED MOUSE. T. Kashiwabara (Ibaraki Univ., Japan). Ibaraki Daigaku Nôgakubu Gakujitsu Hôkoku, 5: 133-46(1957).

Adult male mice of 3 inbred strains 2 to 3 months of age, were exposed to single x-ray doses of 150 to 5000 r. The testes were removed at varying intervals after irradiation, and the degenerative and regenerative processes of germinal epithelium were examined cytologically. The relationship between single doses of x rays and mortality in mice was found to be of a sigmoid type. Both tests and seminiferous tubules were much reduced in size on the 30th to 40th day after 500 r and 1000 r irradiations, and the re-pairing of injured testes was observed between the 20th and 110th day following treatment. Based on the histological observations and breeding tests, 1000 r was sufficient to produce permanent sterility, 500 r produced temporary sterility, and 250 r was the minimum dose to give changes of the spermatogenesis. After 500 r and 1000 r irradiation, mitosis disappeared in 10 to 20 days after exposure, and most of the tubules consisted of a single layer of spermatogonia and Sertoli cells in 20 to 25 days; spermatozoa completely disappeared in 25 to 40 days. Repair of spermatogenesis began to appear in spermatogonial division at the 25th day after 500 r irradiation, and on the 45th to 60th day spermatozoa could be found again. In mice irradiated with 1000 r many tubules did not recover. As cytological phenomena taking place in association with the degeneration stickiness and swelling of chromosomes, chromosome bridges at anaphase of meiosis, scattering or displacement of chromosomes at metaphase, irregular distribution of chromosomes at anaphase, varying number of chromosomes, formation of bi- and multi-nucleate cells, uni- and multipolar mitoses, like lamp-brush chromosome at pachytene stage, and many aberrations of mitochondria were observed. Residual spermatogonia were poor in DNA content, and developing spermatogonia were considered to be relatively radioresistant. (Abstr. Japan. Med., 1: No. 7, 1960.)

22032 ON THE EFFECTS OF X-IRRADIATION ON THE CHROMOSOMES OF YOSHIDA SARCOMA CELLS. Takeshi Seto. Idengaku Zasshi, 35: 388-92(Dec. 1960). (In Japanese)

The Yoshida sarcoma, a rat ascites tumor, was irradiated with x rays at dosages of 500 r, 1000 r, and 1500 r, and the chromosomes were observed in the tumor cells. It was found that the chromosome-number mode of tumor cells in unirradiated tumor-bearing animals occurred at 40. The chromosomes were morphologically analyzed according to the system of Tjio and Levan (1956), and the number of chromosomes assorted in three morphological groups was 13 for M, 13 for S, and 14 for T. Breaks and translocations of chromosomes were rather common and remarkable in metaphase cells observed in irradiated tumor-animals. It was observed in individual cells that there was no constancy in the number of M, S, and T chromosomes which were unaltered by irradiation. From this result, it seems probable that there is no differential radiosensitivity by chromosomes of different types. Two chromosomes of M type are outstanding as marker elements because of their remarkably large size. In the two marker chromosomes, the frequency distribution of breakage was observed after irradiation, and showed that the breakage was rather frequent on both arms around positions one-fourth distant from centromere. (auth)

22033 STUDIES ON THE DAMAGE CAUSED BY RADIOACTIVE SUBSTANCES. II. LONGTERM OBSERVATIONS FOLLOWING THE APPLICATION OF A SMALL AMOUNT OF RADIOACTIVE SUBSTANCE. S. Tasaka (Tokyo Univ.). Igaku to Seibutsugaku, 51: 242-5(1959).

One, two, and three months after the administration of 1 to 5 µg of a radioactive substance into the abdominal cavity of mice, they were autopsied and the distribution in

the various organs was measured by the ion-exchange method. The amounts counted in the various organs after 6 weeks were 10% in the liver, 5% in the spleen, kidney, and muscle, very little in the lung and heart, and 70% in the skeleton. The radioactive substances were gradually transferred to the skeleton. Histologically slight liver cell damage only was observed. (Abstr. Japan. Med., 1: No. 1, 1960)

22034 EFFECTS OF PROTECTIVE CHEMICALS ON THE MALE GONADS AND GENETIC INJURY DUE TO IONIZING RADIATIONS. I. EFFECT OF CYSTEINE ON THE PREGNANCY RATE AND NUMBER OF OFFSPRINGS IN MICE. M. Ohira, Y. Mochizuki, T. Kuroda, K. Okahira, and M. Hamasaki (Okayama Univ., Japan). *Igaku to Seibutsugaku*, 53: 216-20(1960).

Administration of cysteine to mice before irradiation was somewhat protective against male sterility caused by irradiation of ionizing radiation. (Absts. Japan. Med., 1: No. 7, 1960.)

22035 EFFECT OF X-IRRADIATED SERUM ON THE LIFE SPAN OF RED BLOOD CELLS IN NORMAL RABBITS. T. Shoji (Nagoya Univ., Japan). *Igaku to Seibutsugaku*, 53: 225-8(1959).

Serum, removed from rabbits irradiated by a single whole-body exposure of 600 r, was injected into normal rabbits intravenously. The life span of the red blood cells was not influenced by the injection of the serum extracted 2 hr after irradiation, but the serum at the 15th day caused shortening of the life span. No effect was found in serum taken on the 42nd day after irradiation. (Abstr. Japan Med., 1: No. 8, 1961)

22036 EFFECTS OF PROTECTIVE CHEMICALS ON THE MALE GONADS AND GENETIC INJURY DUE TO IONIZING RADIATIONS. II. EFFECT OF CYSTEINE ON THE IRRADIATED TESTIS IN MICE FROM A HISTOLOGICAL POINT OF VIEW. M. Ohira, Y. Mochizuki, T. Kuroda, K. Okahira, and M. Hamasaki (Okayama Univ., Japan). *Igaku to Seibutsugaku*, 54: 111-15(1960).

Cysteine was given following x irradiation to study the protective effect of the SH-group on radiation injury. The testicular changes were followed histologically with elapsed time. Just after irradiation germ cells were found to be destroyed; they were not influenced by an administration of cysteine. In the regeneration stage of the germ cells, over half of the mice treated by cysteine showed favorable results in the regenerative process. Therefore, an administration of cysteine seems to have a possible protective action for the irradiated testis. (Absts. Japan. Med., 1: No. 7, 1960.)

22037 DIRECT AND ABCOPAL EFFECTS OF X-RADIATION ON THE THYMUS OF THE WEANLING RAT. A. W. Law and R. H. Mole (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). *Intern. J. Radiation Biol.*, 3: 233-48(May 1961). (In English)

The effects on the thymus of 50 r whole-body irradiation and of 50 r to the anterior half of the body, as judged by changes in weight and DNA-content, were indistinguishable. The direct effect of radiation was not altered by adrenalectomy and was recovered in five days. Using the same criteria of effect, an abscopal effect on the thymus was demonstrated after 500 r to the posterior half of the body. The abscopal effect was at its greatest 5 days after irradiation and appeared to be due solely to a reduction in food-intake, since it could be almost exactly imitated by simple restriction of food-intake to the same level as that caused by the irradiation. There was a curvilinear relation between thymic weight and body-weight. Adrenalectomy and food restriction altered this relation in opposite directions. (auth)

22038 THE RADIOSENSITIZING EFFECT OF THIOGLYCOLIC ACID, DITHIODIGLYCOLIC ACID, AND HOMOCYSTEINE ON MUSCLE GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE. Rolf Lange and Alexander Pihl (Norwegian Radium Hospital, Radiumhospitalet, Norway). *Intern. J. Radiation Biol.*, 3: 249-58(May 1961). (In English)

It is demonstrated that thioglycolic acid and its disulphide, dithiodiglycolic acid, and homocystine, have a pronounced radiosensitizing effect on the x-ray inactivation of crystalline rabbit-muscle glyceraldehyde-3-phosphate dehydrogenase in solution. A number of other thiols and disulphides tested exert a protective effect. The radiosensitization observed is associated with a disappearance of free enzyme SH-groups, which can be reversed by addition of excess thiols after the radiation exposure. The data indicate that the sensitizing mechanism involves a blocking of essential enzyme SH-groups through a radiochemical formation of mixed disulphides between the enzyme SH-groups and the radiosensitizing substances. (auth)

22039 THE SENSITIZING EFFECT OF WHOLE-BODY X-IRRADIATION IN GUINEA-PIGS. N. Allegretti, V. Staneković, Š. Vlahović, and S. Šestan (Institute 'Ruder Bošković,' Zagreb). *Intern. J. Radiation Biol.*, 3: 259-63(May 1961). (In English)

An intravenous injection of homologous intestinal extract induced in about 60% of total-body x-irradiated (400 or 450 r) guinea pigs caused a reaction with symptoms resembling the anaphylactic reaction. The reaction was maximal about the eighth post-irradiation day. The reaction was observed when extracts deriving either from normal or from irradiated animals were used. The attempt to sensitize normal guinea pigs with the intestinal extract was not successful. (auth)

22040 ON THE ROLE OF NUCLEAR DAMAGE IN THE REGENERATION OF IRRADIATED TISSUES. I. M. Shapiro (Severztov Inst. of Animal Morphology, Academy of Sciences, Moscow). *Intern. J. Radiation Biol.*, 3: 293-306(May 1961). (In English)

During interphase, prior to the first post-irradiation mitosis, the preservation of a percentage of cells with chromosomal aberrations (bridges, acentric fragments) takes place in the rat liver and in the corneal epithelium of the mouse. Cells of corneal epithelium with such aberrations die in F_1 - F_3 or F_1 . The dose-dependence relationship of the percentage of corneal cells with aberrations was obtained. Circa 100 per cent of cells had lethal chromosomal rearrangements after being exposed to 2 to 3 kr of x rays. Mitotic activity recovered, but only in part, after x-irradiation with 10 to 30 kr. The formation of giant polyploid cells from irradiated diploid ones was demonstrated. It was calculated that the percentage of cells without bridge and acentric fragments increased two times and the mitotic index 1.5 times after exposure in CO₂-atmosphere as compared with irradiation in air. The differences of the mitotic index and the percentage of cells with aberrations in mouse corneal epithelium were used as a model for these estimations. Hypothermia (21°) during irradiation had no protective effect on the rate of mitotic activity recovery and on the percentage of cells with aberrations. (auth)

22041 RADIOSENSITIVITY OF SINGLE- AND DOUBLE-STRANDED DEOXYRIBONUCLEIC ACID. E. Weissberger and S. Okada (Univ. of Rochester School of Medicine and Dentistry, N. Y.). *Intern. J. Radiation Biol.*, 3: 331-3(May 1961). (In English)

DNA prepared from calf thymus was used. Double-stranded DNA was converted to single-stranded. It was concluded that if DNA in the dividing cells undergoes a

double-single transition before its replication, it may have an important radiobiological implication with respect to radiosensitivity of different stages of the cells. (P.C.H.)

22042 ACTIONS OF RADIATIONS ON ENZYMES. III. THE INACTIVATING MECHANISM OF SULPHYDRYL ENZYMES BY γ -IRRADIATION (ENGLISH TEXT). S. Tanaka, H. Hatano, and S. Ganno (Kyoto Univ.). *J. Biochem. (Tokyo)*, 47: 361-8(1960).

Among the oxidizing agents produced by irradiation of water by γ rays, OH and O_2H radicals and hydrogen peroxide were proved to be effective in causing inactivation of the enzymes whose sulphhydryl groups are responsible for their activity. In the case of yeast alcohol dehydrogenase, it was shown that 46.5% of the inactivation was caused by OH radicals, 29.3% by O_2H radicals, and 24.2% by hydrogen peroxide. When cysteine in aqueous solution was irradiated by γ rays the amount of sulphhydryl groups of cysteine molecule was found to decrease linearly with dose. It was demonstrated that the amounts of sulphhydryl groups in yeast ADH and liver glutamic dehydrogenase decreased with the increase of dose. In the case of urease, irradiation caused a lowering of enzyme activity in proportion to the decrease in amount of the sulphhydryl groups. The mechanism of inactivation of sulphhydryl enzymes caused by ionizing radiation as proposed by Barron was confirmed in the case of the inactivation of urease by relatively moderate doses. (Absts. Japan. Med., 1: No. 7, 1960.)

22043 NUCLEAR CHANGES IN THYROIDAL EPITHELIUM FOLLOWING RADIATION FROM RADIOIODINE. Brown M. Dobyns and Irene Didschenko (Western Reserve Univ. School of Medicine, Cleveland and Cleveland Metropolitan General Hospital). *J. Clin. Endocrinol. and Metabolism*, 21: 699-720(June 1961).

A quantitative histochemical method was used to measure desoxyribonucleic acid (DNA) in the nuclei of rat thyroid cells after the animals had been subjected to varying doses of I^{131} . Only nuclei with diploid values for DNA were found in the normal thyroid. The administration of thiouracil to nonirradiated rats produced nuclei containing increased amounts of DNA, up to twice the diploid value, or the level at which cell division normally occurs. After moderate doses of radiation, bizarre nuclear forms containing unusually large quantities of DNA were found. These forms were also observed after very small doses of radiation followed by administration of thiouracil. Thus, seemingly insignificant doses of radiation, which did not impair physiologic function, produced latent changes which became evident only with an added stimulus for cell division. To complement these observations, it was found that even small amounts of radiation impaired the ability of the gland to hypertrophy when a goitrogen was given. The increase in DNA indicates that the cells were preparing to divide, either under the influence of an endogenous stimulus, or in response to theouracil. DNA continued to accumulate in abnormal quantities in these nuclei after cell division should have occurred. It is concluded that radiation in some way alters the genetic mechanisms, perhaps by destroying chromosomes, so that the abortive cell division results in amounts of DNA which do not fall into recognizable nuclear classes. The clinical significance of these changes in the thyroid is speculative. (auth)

22044 EFFECT OF ULTRAVIOLET RADIATION ON THE GROWTH AND NUCLEIC ACID SYNTHESIS IN VIBRIO CHOLERAEE. P. Sagar, N. K. Kapoor, and S. C. Agarwala (Central Drug Research Inst., Lucknow, India). *J. Sci. Ind. Research (India)*, C, 20: 166-8(1961).

Ultraviolet irradiation of *Vibrio cholerae* seems to immediately interfere with the ability of the cells to form deoxyribonucleic acid. This effect, though reversible to a greater or lesser extent depending upon the dose, is followed by lysis and the breakdown of the cellular nucleic acids in the later stages. Growth in the irradiated cultures also results in abnormally long cells. Addition of cysteine to the cells prior to irradiation markedly reduces the effect of ultraviolet irradiation, its protecting action increasing with its concentration. Addition of cysteine after ultraviolet treatment, however, is ineffective whether the irradiation is carried out in the cold or at room temperature. (auth)

22045 PATHOLOGICAL EFFECT OF X-RAYS ON RABBITS. H. Shimizu (Univ. of Kanazawa, Japan). *Juzen Iggakkai Zasshi*, 62: 103-31(1959).

X rays of 350 to 18700 r (1500 r daily in one group and 50 to 850 r daily in another group) were given to the upper abdomen of 28 rabbits for 1 to 77 days. The various organs were studied histologically. In the hearts of the group irradiated with large doses, degeneration and atrophy were generally observed and hemorrhage was seen in some cases. Marked degeneration and atrophy of the mucous membrane were present in the digestive tract. In the pancreas there was a tendency to hyperplasia of epithelial cells. In the kidney marked proliferation of Becher-Goormaghtigh's cells and the macula densa and appreciable degeneration of Henle's loop were observed. In the spleen there were destruction of the follicles, slight fibroadenia, and marked hemosiderin pigmentation. The progressive changes were attributed to the primitiveness and polyvalency of each intercalary portion. (Abstr. Japan Med., 1: No. 2, 1960)

22046 ELECTRIC POTENTIAL, RESISTANCE AND TEMPERATURE OF THE SKIN AFTER X-RAY IRRADIATION. H. Miyamoto and A. Kuwakino (Univ. of Kagoshima, Japan). *Kagoshima Igaku Zasshi*, 32: 564-7(1959).

The electric resistance, electrostatic potential, and temperature of the skin were measured after x irradiation. Rabbits were exposed to single x-ray doses of 500 to 3,000 r. The electric resistance slightly decreased just after irradiation. However, it gradually increased again. The electrostatic potential was more or less decreased after x irradiation. The maximum decrease was seen in the erythema stage. Some temperature elevation was observed immediately after irradiation of 200 r. However, after exposure to over 1,500 r the temperature dropped. These influences of x ray appeared milder in cases exposed to fractionated doses. These changes may be due to dysfunction of the autonomic nervous system or circulation disturbance. (Abstr. Japan. Med., 1: No. 1, 1960)

22047 INFLUENCE OF METHIONINE ON LEUCOPENIA CAUSED BY X-RAY IRRADIATION. M. Yamauchi (Univ. of Kanazawa, Japan). *Kanazawa Irigaku Soshu*, 52: 133-88(1959).

White adult male rabbits were exposed to whole-body x irradiation of 200 r, 600 r, and 1,000 r, and subcutaneous injections of L-methionine were given. Relative leukocytosis and pseudo-eosinophilia with a progressive shift to the left resulted from a single administration of methionine. When a single injection was combined with x irradiation, the leukocyte count decreased regardless of whether methionine was injected before or after the irradiation. When x irradiation was given in doses of 600 r, moderate recovery from leukopenia was observed following a single methionine injection. When methionine was injected for 7 days beginning before and ending after the irradiation of 600 r, leukopenia was only slight. There was an appreciable increase of migratory function of leukocytes,

particularly with pre-irradiation methionine. This may be a functional compensation for leukopenia following x irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22048 EFFECT OF P^{32} , S^{35} , AND I^{131} ON THE HAEMOGRAM AND MIGRATION OF LEUCOCYTES OF RABBITS. H. Kimura (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 53: 21(1959).

Changes in the blood picture and the migrating velocity of pseudo-eosinophils were studied following the i.v. injection of the radioactive isotopes P^{32} , S^{35} , and I^{131} . The erythrocyte count fell after injections of 250 μ c of P^{32} and 500 μ c or 1000 μ c of P^{32} , S^{35} , or I^{131} ; after 250 μ c of S^{35} or I^{131} the eventual decrease was preceded by a slight transient increase. The leukocyte count showed a decrease after an initial increase with 250 μ c of P^{32} , S^{35} , or I^{131} , 500 μ c of P^{32} or S^{35} and 1000 μ c of S^{35} ; there was a marked decrease with 500 μ c of I^{131} and 1000 μ c of P^{32} or I^{131} . The pseudo-eosinophil count increased markedly with 250 μ c of P^{32} , decreased after an initial increase with 250 μ c of S^{35} or I^{131} and 500 μ c or 1000 μ c of P^{32} , S^{35} , or I^{131} . There was a striking decrease in the lymphocyte count with 250 μ c of P^{32} or S^{35} , 500 μ c of P^{32} or I^{131} ; a slight decrease with 1000 μ c of P^{32} or I^{131} ; a decrease after an initial increase with 250 μ c of I^{131} or 1000 μ c of S^{35} . There was a shift to the right following an initial shift to the left with 250 μ c of P^{32} , 500 μ c of S^{35} or I^{131} ; a shift to the right with 250 μ c of S^{35} , or 500 μ c or 1000 μ c of P^{32} ; a shift to the left with 250 μ c of I^{131} or 1000 μ c of S^{35} or I^{131} . The migrating velocity of pseudo-eosinophils was accelerated by 250 μ c of P^{32} ; inhibited by 250 μ c of S^{35} , 500 μ c of P^{32} or S^{35} and 1000 μ c of I^{131} ; accelerated after a temporary inhibition by 250 μ c or 500 μ c of I^{131} ; and suppressed after a temporary acceleration by 1000 μ c of P^{32} or S^{35} . Thus, injury to the blood and to the migration of leukocytes was most severe after i.v. injection of P^{32} , least severe with S^{35} , and intermediate with I^{131} . The larger the amount injected, the greater the damage. (Abstr. Japan Med., 1: No. 8, 1961)

22049 STUDIES OF FOETAL ENVIRONMENT. EXPERIMENTAL PRODUCTION OF MALFORMATION BY CHANGING FOETAL ENVIRONMENT. II. ABNORMAL DEVELOPMENT DUE TO RADIATION. I. X-RAY IRRADIATION RELATION BETWEEN DOSE AND DEVELOPMENTAL ABNORMALITIES. U. Murakami and Y. Kameyama (Nagoya Univ., Japan). Kankyo Igaku Kenkyujo Nempo, 9: 164(1958).

Pregnant mice were irradiated with 150, 100, 50, or 25 r of x rays on the 8th day of gestation. The incidence of developmental abnormalities and the intensity and localization of malformations in the CNS usually paralleled the dosage. However, the type and degree of embryonic changes were quite different in each group. Embryos receiving more than 100 r had complex abnormalities involving all germ layers—a typical reaction to x irradiation. Irradiation with less than 100 r caused simple CNS abnormalities, but no mesodermal malformation. It is concluded that different doses cause different types and degrees of malformation when applied to developing embryos of the same age. (Abstr. Japan Med., 1: No. 2, 1960)

22050 EFFECT OF X-IRRADIATION ON TISSUE PROTEIN. S. Suzuki, S. Hashimoto, I. Tanada, S. Tsunashima, and T. Watanabe (Keio Univ., Tokyo). Keio Igaku, 37: 344-9(1960).

Tissue protein in serum, spleen, liver, and kidney was measured after x irradiation. Total protein decreased in each tissue. The serum showed a decrease of albumin and an increase of γ -globulin. In the liver the tissue protein decreased in albumin and α -globulin and increased in β -globulin. In the kidney, no change of albumin level re-

sulted, but marked variation of β -globulin was seen. The level of γ -globulin appeared to be increased. The use of cobalt-greenpole caused an increase of total protein in each tissue and prevented the change of each protein segment. (Abstr. Japan. Med., 1: No. 7, 1960.)

22051 THE EFFECT ON EXPERIMENTAL ANAEMIA OF RADIOACTIVE Co^{60} -CHLOROPHYLLIN, ITS DISTRIBUTION IN THE BODY AND THE THERAPEUTIC EFFECT OF Co -CHLOROPHYLLIN ON ANAEMIA. K. Tamura (Second Tokyo National Hospital, Tokyo). Keio J. Med. 36: 519(1959).

When 5 mg of non-radioactive Co -chlorophyllin was injected before irradiation, either two 300 μ g or one 500 μ g injection, inhibition of the decrease in the blood cell counts and promotion of recovery were more marked than in controls receiving no injections. The pre-irradiation administration was more effective than the postirradiation injection. The intravenous injection of non-radioactive Co -chlorophyllin increased the leucocyte count and hemoglobin content in normal rats, but the increase mostly took biphasic curves. The radioactive Co -chlorophyllin was accumulated and was stored for a long time mostly in the RES such as the liver, spleen, and bone marrow, and directly or indirectly stimulated hematopoiesis. Co -chlorophyllin was injected intravenously in 200 cases of malignant tumor treated with irradiation and the changes in the hemoglobin content, erythrocyte, and leucocyte counts were compared with those in 70 cases treated with radiation alone. In the Co -chlorophyllin injected group, the increase in the hemoglobin content, erythrocyte, and leucocyte counts was more marked, and the inhibition of decrease in the blood cell counts was also stronger than in the uninjected group. Fifteen to 25 mg are the optimal individual doses, the optimal total dose being 1000 mg. (Abstr. Japan Med., 1: No. 2, 1960)

22052 EFFECT OF IONIZING RAYS ON THE METABOLISM OF CELLS. S. Hayakawa (Gunma Univ., Maebashi, Japan). Kitakankyo Igaku, 9: 527-37(1959).

Effects of x irradiation on Yoshida's sarcoma including wandering single cells were investigated with Warburg's apparatus. The respiration of Yoshida's sarcoma was slightly inhibited by irradiation in doses of 5,700 r. An increase of endogenous respiration, however, was sometimes observed, when the cell density was below 600 or above 950 cu mm. Aerobic sugar decomposition was more inhibited than respiration. Anaerobic sugar decomposition was most sensitive. (Abstr. Japan. Med., 1: No. 1, 1960)

22053 EXPERIMENTAL STUDIES ON THE EFFECT OF X-RAY IRRADIATION TO THE HEADS OF MICE. M. Akiyama (Gunma Univ., Maebashi, Japan). Kitakankyo Igaku, 9: 853-82(1959).

The heads of male mice weighing 20 to 23 g were irradiated with x rays in a dose of 2×10^4 r. Test chemicals were administered before and after the irradiation. Characteristic neurological signs caused by irradiation, such as epileptic convulsions, were observed. The survival times of the animals were recorded, and the histological changes of the brain tissues were studied. Cysteine and also chlorothiazide had a protective effect against both the neurological signs and the fatal damage to the brain caused by the irradiation, but NaCN had little effect. Chlorpromazine protected against the former but was ineffective against the latter. Soluble barbitol, urethan, diphenylhydantoin, promethazine, caffeine-sodium benzoate, and camphor had similar effects as chlorpromazine. Morphine hydrochloride had some protective effect against both. The effect of sodium thiopental, DOCA, and magnesium sulfate was similar to that of morphine-HCl. Vasopressin enhanced the

damage to a certain degree. No definite parallelism was seen between the effects of the drugs on the neurological signs produced by irradiation and the lethal rate. The effect of the chemicals on the fatal injuries varied with the doses injected. It is consequently considered that dehydration in the brain tissues was probably an important factor in the fatal cases. (Absts. Japan. Med., 1: No. 7, 1960.)

22054 FUNDAMENTAL STUDY ON THE COMBINED USE OF RADIATION AND CHEMICALS TO INTENSIFY THE ACTION OF RADIATION. I. EFFECT OF SEVERAL CHEMICAL AGENTS ON X-IRRADIATION IN VITRO.

H. Mochizuki (Gunma Univ., Maebashi, Japan). Kitakanko Igaku, 9: 1211-21(1959).

Five days after the transplantation of Yoshida ascites sarcoma into the peritoneal cavity of Wistar strain rats, the ascites fluid was extracted and irradiated. There was no intensifying effect when the combination of x ray and moniodoacetate was used. Rather, some protective effect was found. The combined use of x ray and 2×10^{-3} M of cysteine caused neither intensifying action nor protective effect. The use of 2×10^{-3} M of DL-glutamic acid alone caused no cancerous effects; however, an intensifying action was seen when it was used in combination with radiation. Neither indirect action nor effect of chemicals resulted in the subcutaneous tumors transplanted 2.5 cm apart. (Absts. Japan. Med., No. 7, 1960.)

22055 FUNDAMENTAL STUDY ON THE COMBINED USE OF RADIATION AND CHEMICALS TO INTENSIFY THE ACTION OF RADIATION. II. EFFECT OF D-GLUTAMIC ACID ON X-IRRADIATION IN VITRO. H. Hochizuki (Gunma Univ., Maebashi, Japan). Kitakanko Igaku, 9: 1221-5(1959).

Though 1 mg/kg of D-glutamic acid was administered daily for 5 days to mice with Yoshida subcutaneous tumors, no influence on the growth of tumor was found. When, after a single administration of 1 mg/kg of D-glutamic acid, 700 r of x ray were given, about a 4-fold intensifying action resulted as compared with the control animals. However, no effect was seen when the same doses were injected into the peritoneal cavity every day. Ten mg/kg of the agent showed some developmental inhibition, but this was not marked. Thus, D-glutamic acid was less toxic for the living body, and showed an intensifying action. Therefore, this agent can be used for clinical purposes. (Absts. Japan. Med., 1: No. 7, 1960.)

22056 EXPERIMENTAL STUDY ON EFFECTS OF X-IRRADIATION ON Zn^{65} METABOLISM. II. EFFECT OF X-IRRADIATION ON BODY DISTRIBUTION OF Zn^{65} IN NORMAL AND CANCER-BEARING MICE. K. Musha (Gunma Univ., Maebashi, Japan). Kitakanko Igaku, 10: 119-23(1960).

The body distributions of Zn^{65} in normal mice and mice with Ehrlich's tumors were examined, and the effects of x irradiation on the tissues and tumor cells were studied. In the mice with Ehrlich's ascites cancer and with subcutaneous tumor the uptake rate of Zn^{65} was diminished in the pancreas and was increased in the liver. When normal mice were exposed to a single whole-body x irradiation of 200, 1000, or 5000 r, the uptake of Zn^{65} was decreased in the pancreas and was increased in the liver about 2 hr after irradiation. Such a tendency appeared to be inverted with time. Mice with ascites tumor irradiated by 200 r and 1000 r whole-body irradiation showed approximately the same distribution of Zn^{65} in the body. In 3 to 7 days after irradiation of 1000 r on the subcutaneous tumor region, the uptake rate of Zn^{65} in the liver and spleen appeared normal. (Absts. Japan. Med., 1: No. 7, 1960.)

22057 BLOOD PICTURE OF X-RAY WORKERS IN JAPAN. S. Hibino, H. Tsukamoto, M. Miura, and Y. Kaga (Nagoya Univ., Japan). Koshu Eisei, 23: 555-62(1959).

The hematological data of x-ray workers in Japan and the blood picture in radiation injury are described. X-ray workers were prone to reduced blood hemoglobin, elevation of color index, increased size and volume of erythrocytes, leucopenia, and thrombocytopenia. From these data hyperchromic anemia with an increase in both size and volume of erythrocytes and leucopenia may be considered as specific signs of radiation injury and are detectable clinically. These findings are being gradually improved, as protection against x ray and diminishing of exposure dose are becoming widespread. (Abstr. Japan. Med., 1: No. 2, 1960)

22058 STUDY ON COBALT-GREENPOLE. I. THE EFFECT OF COBALT-GREENPOLE ON BLOOD DAMAGE AFTER IRRADIATION. N. Nakashima (Univ. of Kumamoto, Japan). Kumamoto Igakkai Zasshi, 33: 1570-80(1959).

Sixty cases of postoperative malignant tumor treated by deep x-ray therapy were given cobalt-greenpole and their blood pictures were examined. Even during the irradiation, the number of red blood cells and color index were increased and the number of white blood cells was also kept from decreasing. (Abstr. Japan. Med., 1: No. 1, 1960)

22059 STUDY ON COBALT-GREENPOLE. III. THE EFFECT OF COBALT-GREENPOLE ON TISSUE RESPIRATION. N. Nakashima (Univ. of Kumamoto, Japan). Kumamoto Igakkai Zasshi, 33: 1586-9(1959).

The mechanism of the hematopoietic action of cobalt-greenpole was studied by measuring the respiration quotient in the liver, spleen, and bone marrow. Cobalt-greenpole was found to be effective in hematopoiesis in normal white rats and accelerated the Q_{O_2} in the hematopoietic organs. It also inhibited the radiation damage in the blood and the decrease in the Q_{O_2} in the hematopoietic organs of irradiated rats. The protection of the blood from radiation damage by cobalt-greenpole was considered to be due to a combination of activation of the oxidation-deoxidation system in the tissues and acceleration of urination. (Abstr. Japan. Med., 1: No. 1, 1960)

22060 STUDY OF LEUCOCYTOSIS-INDUCING AGENTS PRODUCED BY X-IRRADIATION. T. Mano (Kumamoto Univ., Japan). Kumamoto Igakkai Zasshi, 33: 1772-9(1959).

The leukocytosis-inducing agents produced by x irradiation were obtained by an ammonium sulfate fraction of the serum as material of 0.027% of acquisition rate and 300 times activity. The separated material was a white scale-like crystal, with a melting point of 238°C, non-dialytic, hard water soluble, insoluble in acetone, ethanol, ether, and chloroform. The qualitative test showed Biuret reaction (+), ninhydrin reaction (-), which turned to positive after hydrolysis. The absorption spectrum showed a curve having a maximum ultraviolet absorption at 291 mμ. The elemental analysis gave a formula of $(C_3H_{15}N_2O_3)_n$. The hydrolyzed material was separated by paper chromatography into a ninhydrin-positive spot group containing asparagin acid and a spot group with an ultraviolet maximum absorption at 270 mμ. (Absts. Japan. Med., 1: No. 7, 1960.)

22061 THE DEVELOPMENT OF IMMUNITY TO TRANSPLANTED EHRlich'S CARCINOMA FOLLOWING INJECTION OF CELLS RADIATED WITH LETHAL DOSES OF X-RAYS. T. Miura, T. Yoshinari, I. Kawamoto, and T. Kozuka (Kurashiki Central Hospital, Japan). Kurashiki Chuo Byoin Nempo, 28: 1-10(1959).

Ehrlich's ascites carcinoma cells, exposed *in vitro* to a lethal dose of x rays, were administered to mice for the

purpose of immunization. Then carcinoma cells not exposed to x rays were subcutaneously inoculated into the legs of the immunized animals. The tumor growth at the injected sites was examined. In mice, pre-treated once (one injection for immunization), the growth of tumor cells was markedly inhibited at 3 weeks after immunization: 30% showed negative transplantation and 30% showed marked delay of development of tumor tissue. In the group pre-treated 3 times the inhibiting effect was generally lower than in the mice pre-treated once. In the controls, x-irradiated liver tissue was used as material for pre-treatment. No appreciable difference in growth of Ehrlich's carcinoma cells between liver-treated and non-treated animals could be observed. (Abstr. Japan. Med., 1: No. 1, 1960)

22062 LATE CHANGES IN THE SMALL INTESTINE CAUSED BY RADIATION INJURY. Felicia Slowik. Magyar Radiol., 12: 36-9(Mar. 1960). (In Hungarian)

The autopsy of a 64-year-old woman who died with encephalomalacia revealed the signs of late x-ray injury in the small intestine. Thirty years before, the patient obtained x-ray treatment for castration. The histological findings and the morphological pathogenesis of the x-ray injury are described. (auth)

22063 DATA ON THE PATHOMECHANISM OF THE LATE X-RAY INJURY. Gyula Kiss. Magyar Radiol., 12: 40-2(Mar. 1961). (In Hungarian)

In a patient suffering from cancer of the skin, after fractionate irradiation with 4000 to 6000 r from short distance, the ion permeability of the skin was examined, using the Storz method. Marked reduction of the ion permeability of the irradiated skin area was found, persisting even for several years. Simultaneously the nutrition of the skin is impaired, sometimes producing late x-ray injuries. (auth)

22064 ANNUAL VARIATION IN THE BLOOD PICTURES OF X-RAY TECHNICIANS. Y. Kaga (Nagoya Univ.). Nagoya Igaku, 80: 704-22(1959).

During the 6 years since 1952, 6129 blood counts were determined in x-ray technicians. There was a decrease in erythrocytes, hemoglobin content, reticulocytes, and platelets. The anemia was hyperchromic, macrocytic, and spherocytic. There was leukopenia, an increase in eosinophils and monocytes, and a decrease in lymphocytes. An increase in Demel's granules in lymphocytes was noted. These abnormalities tended to disappear with the lapse of several years. (Abstr. Japan Med., 1: No. 8, 1961)

22065 CLINICAL STUDIES ON THE EFFECT OF SMALL DOSES OF X-RAY IRRADIATION ON BLOOD CELL COUNTS. M. Miura (Nagoya Univ., Japan). Nagoya J. Med. Sci., 22: No. 2, 195(1959).

The blood of 14 x-ray technicians was examined monthly. Their RBC and hemoglobin content were the same as in controls. In the controls neutrophils, lymphocytes, eosinophils, and monocytes were decreased from May to Oct. This was not observed in the x-ray technicians. There was no seasonal change in the thrombocyte counts in technicians or controls. (Abstr. Japan Med., 1: No. 2, 1960)

22066 HAEMATOLOGICAL INVESTIGATION OF ACUTE AND CHRONIC RADIATION INJURIES WITH SPECIAL REFERENCE TO THE THROMBOPOIETIC SYSTEM. II. EXPERIMENTAL STUDY. T. Matsuki (Kyoto Univ.). Naika Hôkan, 6: No. 2, 132-59(1959).

In rabbits exposed to small daily doses of x rays for a long period the platelet count remained normal, while the area index increased gradually, and the granule index showed a tendency to decrease. In rabbits exposed re-

peatedly to x-ray irradiation of 25 to 200 r the platelet count decreased rapidly followed by a temporary increase in the early stage. The area index increased proportionally to the platelet count after an initial decrease. Even when the platelet count returned to normal following whole-body irradiation by x rays, the area index was still decreased. In rabbits given 500 μ c of radiostrontium or radiophosphorus intravenously, the changes in platelets were essentially the same as in rabbits given whole-body x irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22067 HAEMATOLOGICAL STUDY ON ACUTE AND CHRONIC RADIATION INJURIES WITH SPECIAL REFERENCE TO THE THROMBOPOIETIC SYSTEM. III. CLINICAL STUDY. T. Matsuki (Kyoto Univ.). Naika Hôkan, 6: 205-20(1959).

Thrombocytopenia, an increased area index, a decrease of granule index, and an increased number of injured forms and stimulated forms of platelets were observed twice a year for two years in 17 x-ray workers. These types of change were more frequently found than those of erythrocytes or leucocytes. In some cases of atomic bomb survivors thrombocytopenia, an increased area index, and an increased number of stimulated forms of platelets were seen even 8 to 9 years after exposure. In patients treated with x rays, the platelet count appeared slightly increased or unchanged, but the area index and granule index showed a tendency to decrease and the number of stimulated forms of platelets appeared to be increased. From these results it was concluded that not only the changes of erythrocytes and leucocytes but also the numerical and morphological changes of the platelets are very important and useful for the hematological diagnosis of radiation injury, especially of the chronic form. (Abstr. Japan. Med., 1: No. 1, 1960)

22068 STUDIES ON THE BIOLOGICAL EFFECTS OF NEUTRONS AND Co⁶⁰ γ -RAYS IN MICE. I. BIOLOGICAL EFFECTS OF NEUTRONS IN MICE. T. Morii (Kyoto Univ.). Naika Hôkan, 6: 453-60(1959).

Mice were irradiated by cyclotron neutrons, including γ rays, and the changes of the body weight, peripheral blood picture, and histological findings were observed. In group 1, given 1.1×10^{11} n/cm², severe intestinal damage and leukopenia were observed. The animals died with a mean survival time of 3 days 3 hours. Their death was probably the acute death due to intestinal radiation. In group 2, given neutrons of a dose between groups 1 and 3, radiation effects were most severe on the 3rd to 5th day and all mice of the sm strain died about the 7th day. Leukopenia and infection may be important causes of death. In group 3, given 4.7×10^{10} n/cm², gross changes became normal by the 4th week, but precise examination revealed long-continued radiation effects. The radiation dose was in this case in the sublethal range. The conclusion was that the radiation effects of neutrons are almost the same as those of the other ionizing radiations. (Absts. Japan. Med., 1: No. 7, 1960.)

22069 RADIOSENSITIZATION OF E. COLI BY PURINE AND PYRIMIDINE ANALOGUES INCORPORATED IN DEOXYRIBONUCLEIC ACID. Henry S. Kaplan, Kendrick C. Smith, and Patricia Tomlin (Stanford Univ., Calif.). Nature, 190: 794-6(May 27, 1961).

Studies on the radiosensitivity of *Escherichia coli* led to the conclusion that both ultraviolet and x-ray sensitivity are increased when the natural bases of DNA are substituted by any of several purine and pyrimidine analogs. Br⁸², S³⁵, and C¹⁴ were used as tracers to determine the effects of x and ultraviolet radiation on the incorporation of xanthine, thioguanine, thymine, and uracil into DNA. (C.H.)

22070 INCREASE OF ALDOLASE ACTIVITY IN BLOOD SERUM FOLLOWING IRRADIATION. B. Dalos (Central Inst. for Radiobiology, Budapest). *Nature*, 190: 817(May 27, 1961).

Experiments showed that aldolase released from liver, and perhaps muscle cells damaged by irradiation, appears in whole blood and plasma 1 to 2 hr later. The determination of aldolase activity in serum may be used as an indication of radiation damage. Preliminary investigations on persons receiving radiotherapy for malignant tumors showed an increase in aldolase activity in whole blood that was several times greater than in blood plasma. (C.H.)

22071 CHANGES IN X-RAY SENSITIVITY OF HeLa CELLS DURING THE DIVISION CYCLE. Toyozo Terasima and L. J. Tolmach (Washington Univ., St. Louis). *Nature*, 190: 1210-11(June 24, 1961).

The possibility that randomly dividing cultures of HeLa S₃9IV cells after x-irradiation are heterogeneous, the cells undergoing small or large but brief fluctuations in sensitivity during the division cycle, was examined by irradiating synchronously growing populations at various times after mitosis. Synchronous and random division, survival of colony-forming capacity, and fractional survival are shown. There were intermitotic fluctuations in sensitivity during interphase, but the causes were not apparent. (P.C.H.)

22072 RADIATION EFFECT ON YEASTS OF THE GENUS CANDIDA BERKHOUT. Armin von Szilvinyi and Uta Rosenkrantz (Agricultural Univ., Vienna). *Nature*, 190: 1212-13(June 24, 1961).

The yeasts were irradiated with x rays and UV light. A new radiation effect, the formation of pseudomycellium; was found. Simultaneously with this formation, the cells lose their Gram-positivity to become Gram negative. So as a result of irradiation (1.54Å), the metabolism of RNA is disturbed. The first attack of x rays on yeasts of the genus *Candida* is inhibition of cell division. (P.C.H.)

22073 THE EFFECTS OF RADIOISOTOPES ON THE MULTIPLICATION OF BREWER'S YEAST. R. Megaro (Nihon Univ., Tokyo). *Nichidai Igaku Zasshi*, 18: 1052-66 (1959).

Seven types of radioactive isotopes, P³², Ca⁴⁵, Zn⁶⁵, I¹³¹, Cs¹³⁴, Ce¹⁴⁴, and the fission products of uranium, were studied for their effect upon the multiplication of brewer's yeast. *Saccharomyces cerevisiae* was cultured at 28°C in Burkeler's medium, and each of the above-mentioned radioactive isotopes was added to the medium so as to be 50 µc/ml. The same amount of nonradioactive isotopes was added to the culture medium as a control. In determining the multiplication of brewer's yeast, the number of yeast per ml was calculated by the same technique as is used for blood counts. The radioactive isotopes inhibited the multiplication of brewer's yeast. The larger the amount of isotope added the greater was the inhibition. The multiplication of brewer's yeast was inhibited when more than a certain amount of non-radioactive Ca and Zn was added. (Abstr. Japan. Med., 1: No. 1, 1960)

22074 EFFECT OF RADIATION ON FRUCTOSE PRODUCTION IN SEMEN. S. Sasabe (Okayama Univ., Japan). *Nippon Hinyokika Gakkai Zasshi*, 50: 394-407(1959).

The fructose content of semen was below normal in 5 of the 14 atomic bomb survivors examined, and in 3 of these the blood sugar level was also lower than normal. After total body x irradiation of mice, no change was observed in the weight of the seminal vesicles, but their fructose content and the blood sugar level gradually decreased as the

dosage was increased. These changes gradually returned to normal by the 7th day after irradiation. Almost the same findings were noted when x irradiation was confined to the testes of mice. (Abstr. Japan Med., 1: No. 8, 1961)

22075 EXPERIMENTAL STUDY ON RADIATION EFFECTS. [PARTS] I AND II. M. Wakimoto (Univ. of Okayama, Japan). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 488-524(1959).

Hematological changes are described which were observed in rabbits after injection of blood which was exposed to x rays *in vitro*. Fifty or 20 ml of blood containing about 8,000 leucocytes per cu mm on the average was taken from a rabbit. It was exposed to 2,000, 3,000, and 5,000 r *in vitro*, and administered intravenously to normal rabbits. Leucopenia resulted, especially in the group given 50 ml of blood exposed to 5,000 r. The larger the volume of blood administered and/or the radiation doses given the more marked was the leucopenia. Erythrocytes containing Heinz bodies increased in accordance with peripheral leucopenia. While the rabbits given 50 ml of blood exposed to 5,000 r showed a considerable decrease of bone marrow cells and fatty degeneration as well as delay of regeneration, proliferative rather than degenerative changes were observed in rabbits given blood exposed to smaller doses of irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22076 STUDIES ON INDIRECT ACTION OF RADIATION. XIII. EFFECT OF RADIATION ON TOBACCO MOSAIC VIRUS (TMV). S. Nakaya (Hokkaido Univ., Sapporo). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 529-37(1959).

The metamorphoses of tobacco mosaic virus (TMV) induced by Co⁶⁰ γ irradiation in doses of 3×10^6 r to 13×10^6 r were observed by means of an electron microscope. The TMV was prepared either dry or in suspension. Most of the TMV used in this experiment were long rods of about 300×15 µµ. Irradiation of dry TMV caused no significant morphological change, but irradiation of TMV in suspension caused a decrease in number of long rods of about 300 µµ, and an increase in the number of rods shorter than 200 µµ. This means that TMV was broken down by irradiation. The breaking down of TMV by irradiation increased its number depending on the irradiation dose and also increased as the solution was diluted in the dilution range of 1/5 to 1/500. (Abstr. Japan. Med., 1: No. 1, 1960)

22077 EFFECT OF RADIATION ON THE ELECTROKINETIC POTENTIAL OF SARCOMA CELLS. VI. EFFECT OF COMBINED USE OF X-RAY AND ANTICANCEROUS AGENTS. A. Yoshikawa (Hokkaido Univ., Sapporo). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 538-47(1959).

The effect of the combined use of x rays and anticancerous agents on the electrokinetic potential on the sarcoma cell surface was examined by means of microelectrophoresis. Sarcoma MTK-111 in rats was irradiated by x rays ranging in dose from 200 to 2,000 r followed by intraperitoneal injection of an anticancerous agent. The electrophoretic mobility of untreated sarcoma cells was on the average $(5 \pm 0.007) \times 10^{-4}$ cm/sec/volt/cm in 460 cases. This value was almost independent of the time since implantation of the sarcoma and of the frequency of punctures for sampling ascites. When irradiated *in vivo* the electrophoretic mobility of the sarcoma cells showed a transient decrease. The isoelectric point of the cell potential was not changed by x irradiation nor by injection of the agents nor by the combined use of them. X irradiation *in vivo* produced little effect on the electrophoretic mobility of the sarcoma cells,

which was more or less decreased after the use of the anticancerous agents. Generally the combined use of x rays and anticancerous agents had a cumulative effect. (Abstr. Japan. Med., 1: No. 1, 1960)

22078 EFFECT OF IN-VITRO X-RAY IRRADIATION ON TRANSPLANTABILITY OF EHRlich ASCITES CARCINOMA CELLS. T. Yoshinari (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 606-17(1959).

When tumor cells are inoculated subcutaneously into the thigh of mice, the growth rate is represented by the difference of the circumferences of the thighs measured before and after transplantation. The experimental relationship between tumor weight and growth was found to be as follows: tumor weight = (tumor growth - 13.10) \times 1/4.98 g. If no less than 4.0×10^4 /0.2 ml of tumor cells were inoculated, all eventually appeared to be positive in transplantation. When the tumor cells were irradiated in vitro before the inoculation, it was observed that the higher the x-ray dose the less the transplantability. In mice injected once with tumor cells damaged by irradiation, the inhibition of the tumor growth was most prominent the third week after the pretreatment. In mice pre-injected three times the transplantability was usually lower than in mice pre-injected once. This was probably due to the active immunizations caused by x-ray-damaged tumor cells. (Abstr. Japan Med., 1: No. 2, 1960)

22079 RADIOSENSITIVITY OF YOSHIDA SARCOMA IN RATS AFTER X-IRRADIATION FOR SUCCESSIVE GENERATIONS. I. STUDY ON RADIO-RESISTANCE. K. Kaneta (Sapporo Medical Coll.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 685-91(1959).

An experiment was made to determine the degree of radio-resistance in tumor cells after exposure for 27 months to 87480 r of x rays in 94 successive generations of Yoshida sarcoma. Whole body irradiation of 1000 r was given to rats with Yoshida sarcoma from the first to the 31st generation, and 2000 r each to those of the 32nd to 94th generation. In every case tumor cells were transplanted into the peritoneal cavity one hour after irradiation. Tumor cells of either the irradiated line or non-irradiated line were transplanted subcutaneously in the right shoulder of rats in order to measure the tumor regression of both lines following local exposure of 1000 r. After tumor cells were transplanted, the irradiated cells developed to three times the number of non-irradiated cells. The cure rate of subcutaneous transplanted tumor of the irradiated line was higher than that of the non-irradiated line. It is concluded that the irradiated line is more radiosensitive than the non-irradiated line. Some tumor stem cells may have undergone a certain type of mutational change after the repeated heavy successive irradiation. The mutant stem cells may be more radio-sensitive than the original stem cells. (Abstr. Japan Med., 1: No. 2, 1960)

22080 NUCLEIC ACID IN THE LIVER CELLS OF MICE AFTER P^{32} INJECTION. S. Aasakumo (Yamaguchi Medical School, Ube, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 692-709(1959).

The successive changes of body weight, P^{32} uptake, and the amount in the liver cells were measured following the injection of various amount of P^{32} (300 μ c, 100 μ c, 50 μ c, 10 μ c, and 1 μ c) into the abdominal cavity. Observations were also made of alterations in cell functions especially of morphological changes of the tissue and abnormal intracellular distribution of nucleic acids (RNA and DNA). The groups receiving 300, 100, or 50 μ c of P^{32} showed moderate decrease in body weight, but the groups receiving 10 or 1 μ c

showed no change. P^{32} uptake by the liver was increased for 3 to 6 hours after injection and decreased rapidly after 24 hr. Changes in cell functions were inferred from the abnormal intracellular distribution of nucleic acids in various organs. Generally, marked changes in RNA preceded those in DNA. After two weeks, the groups receiving 300 μ c showed some, but incomplete, recovery, while those receiving less than 50 μ c had almost complete recovery. (Abstr. Japan. Med., 1: No. 1, 1960)

22081 EFFECTS OF COMBINED USE OF X-RAY AND NITROMIN ON YOSHIDA SARCOMA. VI. STUDY ON THE COMBINED EFFECTS OF RADIATION AND CHEMICALS. I. Motonaga (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 759-68(1959).

The combined effects of x rays and nitromin (nitrogen mustard) on Yoshida sarcoma were studied. When nitromin (0.1 mg/100 g) was given, mitosis was observed in Yoshida sarcoma cells and each mitotic phase became of markedly low incidence. Morphologically most cells in the metaphase had sticky, coalescent, broken, and scattered chromosomes, while most cells in the anaphase showed chromosome bridges and delay. When x rays were used combined with nitromin administration, the effect of x rays and that of nitromin appeared separately and independently. This may be explained by the so-called covering effect theory. Injection of small amounts of nitromin promoted recovery of mitotic activity of cells damaged by x irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22082 STUDY ON THE COMBINED EFFECTS OF RADIATION AND CHEMICALS. VIII. EFFECT OF THE COMBINED USE OF X-RAYS WITH FUMARIC AND MALONIC ACID ON SARCOMA MTK-III. M. Kido (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 769-78(1959).

The combined effect of x rays with fumaric and malonic acid was described. About 3 to 6 days after transplantation of sarcoma MTK-III, adult rats of the Wistar strain were exposed to x-ray irradiation of 200 r. Aqueous solutions of the chemical agents were injected intraperitoneally. After injection of fumaric acid the mitotic index and the metaphase percentage increased slightly. This response was definite only when injection was given within 3 hr before irradiation. However, no morphological effect was found in the chromosomes. The administration of fumaric acid before x irradiation caused a marked decrease of x-ray effect. Malonic acid had an effect on mitosis similar to that of x irradiation. When malonic acid was used together with x irradiation, there was a combined effect, but fumaric acid and x rays had antagonistic effects. The author concluded that one of the effects of x rays on sarcoma MTK-III may be inhibition of the tricarboxylic acid cycle in the succinic acid metabolism. (Abstr. Japan. Med., 1: No. 1, 1960)

22083 STUDY ON THE COMBINED EFFECT OF RADIATION AND CHEMICALS. IX. EFFECTS OF THE COMBINED USE OF X-RAY AND CARZINOPHILIN. N. Funayama (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 779-96(1959).

The effect of the combined use of x rays and carzinophilin, an antitumor agent, was studied. Rats with Yoshida sarcoma were exposed to x irradiation of 200 r. Carzinophilin was injected intraperitoneally. Carzinophilin caused a marked decrease in the mitotic index, but no complete recovery was found even after 3 to 4 days. Morphologically the chromosomes of Yoshida sarcoma cells showed agglutination, coalescence, fragmentation, and bridge formation, while in the cytoplasm vacuoles

and typical amoeboid protrusions were observed. The effect was generally increased with increasing dosage. The combined use of x rays and carzinophilin was much more effective than either used separately. (Abstr. Japan. Med., 1: No. 1, 1960)

22084 EFFECT OF COMBINED USE OF X-RAY AND 6-MERCAPTOPYRINE ON YOSHIDA SARCOMA (COMBINED EFFECTS OF RADIATION AND CHEMICALS, 10th REPORT). T. Tahara (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 791-9(1959).

Rats with Yoshida sarcoma were irradiated with x rays (200 r), and the drug was injected intraperitoneally. About 18 hours after the injection of 2 mg/100 g of 6-mercaptopurine the mitotic index appeared markedly decreased. The incidence of each mitotic phase was moderately diminished; however, various abnormal forms of the chromosomes in the metaphase were recognized. The injection of 100 mg/100 g of 6-mercaptopurine made the mitotic index decrease with the lapse of time. The treated tumor disappeared temporarily 3 days after the injection, and 30% never recurred. (Abstr. Japan. Med., 1: No. 1, 1960)

22085 EFFECT OF β -RAY IRRADIATION ON THE CILIARY MOVEMENTS OF CILIATED EPITHELIAL CELLS OF HUMANS AND RABBITS IN VITRO. O. Ogi (Univ. of Tokushima, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 819-31(1959).

The effect of β -irradiation on the ciliary movements of the ciliated epithelial cells of humans and rabbits in irrigation culture was observed microcinematographically. In irrigation cultures at 37° C, the ciliated epithelial cells of the human maxillary sinus showed the to-and-fro movement 7.8 times per sec on the average. After irradiations at 50 to 100 r on the ciliated epithelial cells of the human maxillary sinus, the ciliary movement was observed to become a little less active. The ciliated epithelial tissue in the maxillary sinus of the rabbit also showed to-and-fro movement. Immediately after irradiations ranging from 700 to 1400 r, the rate of ciliary movement decreased appreciably. No morphological changes were observed. After irradiation by 2800 r the ciliary movement clearly decreased, and it ceased completely about 4 hr after irradiation. Degeneration and desquamation of the epithelial cells were observed simultaneously. As for the individual differences of rabbit maxillary sinus, no significant radiosensitivity was observed. (Abstr. Japan Med., 1: No. 2, 1960)

22086 EFFECT OF X-RAYS ON LIVER FUNCTION. [PART] IV. T. Nakae (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 897-917(1959).

Serum cobalt and cadmium reaction carried out in rats was more or less affected by x rays. The hepatic region was found to be most sensitive. X rays applied to this region in doses of 2000 r or more caused a strongly positive serum reaction nearly in proportion to the doses given. This reaction after irradiation was considered to be due to parenchymal degeneration of the liver. Among many protective agents administered, vitamin B₂ was markedly effective against x radiation; vitamin K, L-methionine, and glucuronic acid were also effective. Serum flocculation reactions carried out in patients receiving x-ray therapy before and after irradiation showed a similar tendency to the above-mentioned experimental result, but no decisive conclusion was obtained because of other clinical complicating factors. (Abstr. Japan Med., 1: No. 2, 1960)

22087 EFFECT OF SIEVE IRRADIATION ON LIVER CATALASE IN RABBITS. XIII. FUNDAMENTAL STUDY

ON SIEVE THERAPY. T. Imamura (Kyoto Prefectural Medical Coll.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 946-56(1959).

The influence of x irradiation by a sieve method on liver catalase was observed and compared with a conventional method. Adult male rabbits were exposed to 800 r of x rays by a conventional method and to 2,000 r by a sieve technique. Liver catalase was measured by Nakahara-Fukuoka's method using Batteri-Stern's apparatus. In both sieve and single irradiation techniques liver catalase was decreased after the irradiation reaching its minimum in 48 hr, followed by gradual recovery. It was evident that the decrease of liver catalase was nearly parallel to the dose and that the decrease after the sieve irradiation was less than after the conventional single exposure, despite the fact that the average x-ray dose given by both methods was physically the same. (Abstr. Japan. Med., 1: No. 1, 1960)

22088 HISTOLOGICAL STUDY ON THE EFFECT OF SIEVE IRRADIATION ON THE LIVER IN RABBITS. XIV. FUNDAMENTAL STUDY ON SIEVE THERAPY. T. Imamura (Kyoto Prefectural Medical Coll.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 957-64(1959).

The influence of sieve irradiation on the liver in rabbits was studied histologically. Rabbits were exposed to 2,000 r by sieve irradiation and to 800 r by conventional single irradiation. Necrosis and degeneration were found in the parenchymal tissue of the liver 6 hours after irradiation by the conventional method. However, the histological changes in the liver 24 hours after the sieve technique irradiation were milder than after the conventional method. Signs of regeneration and recovery appeared at a relatively early stage in the sieve irradiation group. There was a parallelism between the severity of histological changes in the liver and the decrease of liver catalase. (Abstr. Japan. Med., 1: No. 1, 1960)

22089 EFFECTS OF COMBINED USE OF X-RAY AND RIBONUCLEIC ACID (COMBINED EFFECTS OF RADIATION AND CHEMICALS, 11th REPORT). S. Ikeda (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 986-95(1959).

The effects of combined use of RNA and x rays on sarcoma cells are reported. About 3 to 4 days after transplantation, rats with MTK-111 sarcoma were exposed to x irradiation of 200 r. RNA was injected into the peritoneal cavity. After the injection of RNA, the mitotic index appeared appreciably increased, associated with the augmentation of dividing cells in each phase. The injection of RNA before x irradiation caused a marked decrease of mitotic cells and produced a large number of abnormal chromosomes. The effect was considerably stronger than that of the administration of x rays alone. (Abstr. Japan. Med., 1: No. 1, 1960)

22090 BLOOD PICTURE OF X-RAY WORKERS. I. THE LEUCOCYTE COUNTS. Y. Urushiyama (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1159-73(1959).

A hematological follow-up of x-ray and isotope workers at Tohoku University is reported. The workers of the non-medical departments and research institutes used radioactive isotopes of not more than a few mc per day and did not manipulate high voltage x-ray generators. They had no marked changes in their blood pictures, as they were exposed to very low levels of radiation. The total leukocyte count in the members of the Dept. of Radiology and x-ray Technicians in Miyagi Prefecture was generally decreased due to a low neutrophile count. With reduction of exposure, their leukocyte counts tended to improve slowly. Therefore,

a decrease in leukocyte count depends on the dose rather than on the length of duration of radiation work. The workers with a total leukocyte count below 4000 gave the impression of having a fixed and unfluctuating leukocyte level. It was difficult to lead them to recovery. The leukocyte pictures plotted on the hemogram showed a decrease in neutrophils and monocytes and an increase in lymphocytes. However, lymphocyte and monocyte counts tended to increase gradually in each examination. As the total leukocyte counts tended to improve the leukocyte picture remained stationary. (Abstr. Japan Med., 1: No. 8, 1961)

22091 STUDIES ON THE COMBINED EFFECT OF RADIATION AND VARIOUS CHEMICALS ON MITOTIC CELLS. XII. EFFECT OF COMBINED USE OF X-RAY AND ZnSO_4 . T. Fukunaga (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1198-1207 (1959).

The effects on sarcoma cells of ZnSO_4 alone and combined with x rays were tested. The material used was MTK sarcoma 111 of rat, 3 to 4 days after transplantation. An aqueous solution of ZnSO_4 was injected intraperitoneally and the frequency of mitosis, the percentage of each mitotic phase, and the frequency of abnormal chromosomes in the metaphase were determined. ZnSO_4 caused a considerable increase in mitoses of sarcoma cells, mitotic cells being increased in the metaphase, anaphase, and telophase, and decreased in the prophase. In the metaphase, many abnormal chromosomes showed clumping. Injection of ZnSO_4 before x irradiation counteracted the x-ray effect of decreasing mitoses. The peak effect appeared 6 hr after injection. Injection of ZnSO_4 after x irradiation did not change the effect of irradiation. Injection of ZnSO_4 before irradiation also provided some protection against the lethal effects of radiation. (Abstr. Japan Med., 1: No. 8, 1961)

22092 STUDIES ON THE COMBINED EFFECT OF RADIATION AND VARIOUS CHEMICALS ON MITOTIC CELLS. XIII. EFFECT OF COMBINED USE OF X-RAYS AND SUCCINIC ACID. T. Fujimatsu (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1207-16 (1959).

Succinic acid alone and combined with x rays and malonic acid was tested for its effect on sarcoma cells. The material used was the MTK sarcoma 111 of rat, 3 to 4 days after transplantation. An aqueous solution of succinic acid was injected intraperitoneally in rats, and the frequency of mitosis, the percentage of each mitotic phase, and the frequency of abnormal chromosomes in the metaphase were determined. Succinic acid caused a great increase in the number of mitotic cells. Mitotic cells in the prophase and metaphase increased in parallel with the mitotic index, and those in the anaphase and telophase appeared with some lapse of time. The increase in mitotic cells was almost the same with the succinic acid dose range of 10 mg to 68 mg/100 g. In the metaphase, abnormal chromosomes showing signs of stickiness or coalescence were observed. Injection of succinic acid before x irradiation counteracted the mitosis-depressing effect of irradiation. Injection of succinic acid after irradiation restored the mitosis to a marked degree if it were given at least 3 hours after the irradiation, otherwise it was ineffective. The action of succinic acid was antagonized by malonic acid temporarily, but then succinic acid overcame the effect of the latter and accelerated mitosis. In the combined use of succinic acid with malonic acid and x rays, succinic acid could not restore mitosis. (Abstr. Japan Med., No. 8, 1961)

22093 STUDIES ON THE COMBINED EFFECTS OF RADIATION AND VARIOUS CHEMICALS ON MITOTIC CELLS. XV. EFFECT OF COMBINED USE OF X-RAY

AND L-GLUTAMIC ACID. N. Noritsuki (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1227-36 (1959).

L-Glutamic acid alone and combined with x rays and hydroquinone was tested for its effect on sarcoma cells. MTK sarcoma 111 of rats was used and the L-glutamic acid was injected intraperitoneally. It caused marked and prolonged increase in the number of mitoses of sarcoma cells in each phase. In the metaphase there was an increased number of abnormal chromosomes with stickiness and condensation. Injection of L-glutamic acid before irradiation counteracted the decrease in mitoses. The effect was most pronounced when the sarcoma cells were irradiated 1 hr after injection. Less effect was obtained when irradiation was given 3 hr or immediately after injection. Injection of L-glutamic acid 3 hr after irradiation resulted in a marked restoration of mitotic cells. Administration of hydroquinone, even in a very diluted solution, reduced the number of mitoses. This effect was long-acting. L-Glutamic acid counteracted hydroquinone alone or when combined with x rays. (Abstr. Japan Med., No. 8, 1961)

22094 A CASE OF RADIATION PNEUMONITIS WITH SPECIAL REFERENCE TO SEROLOGICAL STUDIES.

S. Tarusawa, C. Sugie, M. Nakamura, T. So, K. Ra, and S. Suzuki (Iwate Medical Coll., Morioka, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1237-42 (1959).

A 75-year-old woman who received deep x-ray therapy for left breast cancer during a period of 2 years developed radiation pneumonitis. She was treated with ACTH-gel with remarkable relief. The amount of auto-antibody paralleled the course of symptoms. The more severe the symptoms the more antibody was produced. The auto-antibody reacted against human-lung tissues more strongly than against rabbit-lung tissues. The auto-antibody reacted against the x-irradiated lung tissue of rabbits more strongly than against non-irradiated lung tissues. (Abstr. Japan Med., 1: No. 8, 1961)

22095 STUDIES ON THE DISTRIBUTION OF RADIO-COLLOIDS (Au^{198} , Lu^{177} , $\text{CrP}^{32}\text{O}_4$) AND THE HISTOPATHOLOGICAL CHANGES IN MICE, PARTICULARLY ON THE RELATIONSHIP BETWEEN IRRADIATED DOSE AND RADIATION HAZARDS. I. Watanabe (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1303-23 (1959).

Colloidal solutions of Au^{198} , Lu^{177} , and $\text{CrP}^{32}\text{O}_4$ were injected into 307 mice subcutaneously, intraperitoneally, and intravenously. One, 7, 14, or 30 days after injection the animals were sacrificed. Radioactivity, microautoradiography and histopathological changes were examined. The radiation doses were also calculated. In the case of a subcutaneous injection, over 90% of the radioactivity remained in the injected site, and no particular changes were found in the internal organs. After intraperitoneal injection, activities ranged from several to 40% were transferred into the liver. Radiogold appeared to be the most definitely transferred, showing strong damage of intestinal epithelial cells which recovered relatively early. Radiation damage seen in the intestine was strongest after injection of $\text{CrP}^{32}\text{O}_4$. In the intravenous injection, about 70 to 90% of the radioactivity was taken up by the liver. Radioactive colloids taken up by the living body deposited in the stellate cells of Kupffer and the pulp of the spleen. When 30 $\mu\text{g/g}$ of $\text{CrP}^{32}\text{O}_4$ were injected, the radiation dose accumulated in the liver until one month after injection it was 95000 rads. Pathologically, edematous degeneration, swelling, nuclear irregularity, and atrophy were seen in the liver. No fibrous tendency was found; this may be due to considerable radioresistance of the liver as compared with the bone marrow. In the dead animals the main changes con-

sisted of aplasia of the bone marrow particularly of the vertebrae, ribs, and sternum which received radiation doses ranging from 2000 to 4000 rads a month. If the same doses were administered, Au^{198} was less injurious to the living body, and $\text{CrP}^{32}\text{O}_4$ was more harmful. This variation could be the result of differences of β -ray energies, half lives and distribution in the bone marrow. (Absts. Japan. Med., 1: No. 1, 1960.)

22096 BLOOD PICTURES OF RADIOLOGICAL WORKERS. II. BLOOD PICTURE IN OCCUPATIONAL RADIATION HAZARDS. Y. Urushiyama (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1324-32(1959).

Cases with abnormal blood pictures due to radiation exposures were picked from the radiological workers at Tohoku University to determine characteristic blood pictures of occupational radiation hazards. The study was carried out on persons with less than 1500 lymphocytes and less than 5000 leukocytes for 2 successive examinations. Decreased total leukocyte and neutrophil-cell counts with unchanged lymphocyte count, decreased counts of total leukocytes, neutrophil cells, and lymphocytes, and almost unchanged total leukocytes and neutrophil-cell counts with decreased lymphocyte count were observed. (Absts. Japan. Med., 1: No. 7, 1960.)

22097 DIURNAL FLUCTUATION OF LEUCOCYTE COUNTS OF SUBJECTS WITH RADIATION HAZARDS. Y. Urushiyama (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1333-45(1959).

To test the supposition that during the day changes occurred in the blood picture of people subject to occupational radiation exposures, workers with marked decreases of leukocyte counts and workers who had recovered from the effects of excessive radiation were selected for study from radiological employees and x-ray technicians. In the cases of long-standing service with persistent leukopenia, the fluctuations in the counts of total leukocytes, neutrophil cells, and lymphocytes were at the same hour every day and within the day very small. In the cases of comparatively short professional service but with persistent leukopenia, the total leukocyte count showed some perceptible increase in the afternoon and the daily fluctuation in the afternoon hours was also somewhat notable. These changes were always predominantly influenced by the neutrophil cells, for the lymphocyte count remained essentially unchanged. In cases newly diagnosed as leukopenia, the daily difference in the total leukocyte count at the same hours was markedly large, especially in the afternoon hours, in some cases amounting to 3000. This fluctuation showed an increase with the lapse of time. These changes were always under the predominant influence of the neutrophil cells, the lymphocyte count remaining nearly unchanged. In cases recovered from radiation effects, the leukocyte counts at the same hour every day and within the day were found to be nearly at the same level throughout. In these changes the neutrophil cell count changed little, and the change in lymphocyte count was rather large, so that these slight fluctuations of the total leukocyte count seemed to be determined by the behavior of lymphocytes. In exposure cases on the way to recovery, the total leukocyte count steadily increased with the lapse of time, and the daily difference at the same hour was large in the afternoon, with the difference sometimes amounting to 2000. The neutrophil cells were mainly involved in these changes of the total leukocyte count, but the change in lymphocyte counts was also comparatively large. (Absts. Japan. Med., 1: No. 7, 1960.)

22098 EFFECT OF X-RAY IRRADIATION ON ORYZIAS LATIPES UNDER DIFFERENT CONDITIONS. VI. EFFECT OF OXYGEN. T. Hishida (Kyoto Prefectural Medical Coll.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1355-9(1959).

The relationship between oxygen content of water and x-ray sensitivity was studied using *Oryzias latipes*. The greater the oxygen content of water, the shorter the life span of fish. This indicates that there is some oxygen effect in *Oryzias latipes*. However, when the oxygen in water was over 40%, no definite increase of oxygen effect was found. The oxygen effect on *Oryzias latipes* may be related rather with oxygen consumption than with oxygen content of blood. (Absts. Japan. Med., 1: No. 7, 1960.)

22099 EXPERIMENTAL STUDY ON RADIOSENSITIVITY. I. EFFECT OF X-RAY PREIRRADIATION ON THE LETHAL RATE OF MICE. K. Yamamoto (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1382-91(1959).

When pre-irradiated mice were exposed again to x rays up to 300 r in total by a single or repeated exposure, a remarkable decrease of the death rate resulted. This indicates that x irradiation itself caused some radioresistance. However, in a case of immediate x irradiation following repeated exposure to small doses of x ray (20 r, 15 times), the death rate appeared to be increased. The results show that there is some important relationship between each amount of fractionally applied irradiation doses and radiosensitivity of the cells in injured tissues. (Absts. Japan. Med., 1: No. 7, 1960.)

22100 EFFECT OF IRRADIATION AT LOWER TEMPERATURE ON THE REGENERATION OF THE AMPHIBIAN TAIL. A. Ashizawa (Nagasaki Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1416-34(1959).

The influence of temperature at the time of irradiation on the radiobiologic effect is still a problem to be studied. The tails of male and female *Triturus pyrrhogaster* were amputated at various intervals following tail irradiation with various doses of x rays. The irradiations were done both at lower temperatures (1 to 8°C) and room temperatures (21 to 24°C). In addition to the investigation of the survival rate and living habits of the animals, macroscopic, stereomicroscopic, and histologic examinations of amputation stumps were carried out at various intervals after amputation and the results of both temperature groups were compared. In general, the radiobiologic effects were diminished by cooling at the time of irradiation with doses of 50 r and 600 r. (Absts. Japan. Med., 1: No. 7, 1960.)

22101 EFFECT OF ADMINISTRATION OF 'CEPHARANTHIN' ON RADIATION DAMAGES. M. Ozeki, T. Nagashima, T. Tasaki, and Y. Koga (Kurume Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1492-5(1959).

Cepharanthin, a type of alkaloid, was injected subcutaneously in mice and rats. In the injected group there was a marked decrease of the death rate and an inhibition of the decrease of body weight. Cepharanthin was effective for reduction of and recovery from radiation anemia and leukopenia. In particular, administration of cepharanthin prevented the acute blood changes following irradiation. This drug was more effective in radiation disease than cobalt-greenpole and may be of some value for clinical use. (Absts. Japan. Med., 1: No. 7, 1960.)

22102 THE RADIOBIOLOGICAL EFFECT OF DIFFERENT DOSE RATES: A STUDY OF WHOLE BODY EXPOSURE OF MICE TO Co^{60} γ -RAY. G. Kusumoto. Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1497-1506(1959).

Adult male mice were irradiated by a series of 4 different dose rates, ranging from 9.5 to 92.4 r/min, using

a 1000-c Co⁶⁰ source. LD₅₀ for each of the 4 dose rates showed a significant difference; the higher the dose rate, the lower the LD₅₀. The survival rate also decreased with an increase of dose rate, when mice were exposed to total-body irradiation of 800 r. Pathological changes were studied using mice irradiated by 800 r of Co⁶⁰ γ ray with dose rates of 85.6 and 9.5 r/min. In a case of higher dose rate, histological damages occurred earlier and more intensively, while regenerative changes were delayed as compared with lower dose rate, the differences being most conspicuous in the bone marrow and spleen. (Absts. Japan. Med., 1: No. 7, 1960.)

22103 STUDIES ON THE COMBINED EFFECT OF IRRADIATION AND VARIOUS CHEMICALS ON MITOTIC CELLS. XVI. EFFECTS OF COMBINED USE OF X-RAY AND THIO-TEPA ON YOSHIDA SARCOMA. T. Umeno (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1597-1608(1959).

In Yoshida sarcoma of rat, 3 to 4 days after transplantation, the frequency of mitosis, change in number in each mitotic phase, and the frequency of chromosome abnormalities in the metaphase and anaphase were observed. Thio-TEPA produced a rapid decrease in number of mitotic cells, which were fewest 9 to 12 hr after injection. Thereafter, they gradually increased in number, but did not return to pre-treatment levels, even at 48 hr. Abnormal chromosomes showing signs of stickiness and/or condensation were observed in the metaphase, and chromosome bridges induced by breakage and stickiness of chromosomes appeared in the anaphase. These so-called radiomimetic effects resemble those of x ray. Combined use of thio-TEPA with x rays showed independent effects, though irradiation after injection resulted in a stronger effect than injection alone, and irradiation before injection reduced the effect of thio-TEPA. (Absts. Japan. Med., 1: No. 7, 1960.)

22104 DISTRIBUTION OF Ce¹⁴⁴-Pr¹⁴⁴ IN MICE, AND PATHOLOGICAL OBSERVATIONS. H. Kakehi, I. Watanabe, M. Miyake, and H. Sugano (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1688-95(1959).

Three μ c/g of Ce¹⁴⁴-Pr¹⁴⁴ were injected into the peritoneal cavity of male mice, 18 g in body weight. The LD₁₀₀ was 27 days and the LD₅₀ was 21 days. Percentage of uptake of Ce¹⁴⁴-Pr¹⁴⁴ was highest in the bone and the bone marrow and next in the liver. The exposure dose was highest in the spleen and then in the testis and liver. Generally speaking, pathological changes were most severe in the mice which died 2 to 3 weeks after injection. Some recovery was seen 4 weeks after injection. The loss of spermatogenesis is worthy of attention. (Absts. Japan. Med., 1: No. 7, 1960.)

22105 EXPERIMENTAL STUDY OF RADIOSENSITIVITY. II. EFFECT OF X-PREIRRADIATION ON RADIOSENSITIVITY OF MICE TESTICLES. K. Yamamoto (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1856-72(1959).

Mice were x-irradiated to observe a change of radiosensitivity when pre-irradiation was given. When mice were irradiated with chronic exposure (1 r per day for 30 days, 1 r per day for 60 days, or 2 r per 2 days for 30 days) some functional change was found in the spermatogenic order. Prior to single whole-body irradiations of 50 or 300 r fractionated chronic exposure was given with the similar dose rate described above. The histological and functional changes were followed with an elapsed time; however, no acquired radio-resistance could be seen. (Abstr. Japan Med., 1: No. 8, 1961)

22106 A STUDY OF RADIATION SENSITIVITY. [PART] I. K. Matsumoto (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1902-14(1959).

Yoshida sarcoma in the form of subcutaneous nodules and ascites tumor in rats were exposed to x rays. Three to 4 days after the transplantation of ascites tumor cells into the subcutaneous tissue a solid tumor grew rapidly. The mean rate of volume increase was $0.29 \sqrt[3]{v}$ per day (v is volume of tumor). The mitotic cycle of the tumor cells was 21.8 hr. When a single dose of 250 or 500 r was given, an appreciable depression of growth of the subcutaneous tumor was observed. When tumor cells were irradiated (500 r), emulsified after 24 hr, and transplanted into the subcutaneous tissue, tumor formation was delayed about 1 day as compared with the control group. Even when irradiation was given successively to 72 successive generations, no definite differences in radiosensitivity of tumor cells between the non-irradiated group, the pre-irradiated group, and the successively irradiated group were noted. (Absts. Japan. Med., 1: No. 7, 1960.)

22107 EFFECT OF X-RAY IRRADIATION OF VERY SMALL DOSES ON THE BLOOD PICTURE. Y. Urushiyama (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2115-25(1960).

The changes in the blood pictures of those engaged in photo-roentgenography and thus exposed to scattered x rays totalling 30 to 200 mr were examined after the end of their work at times of 15 min, 30 min, 24 hr, 48 hr and a week. Most of the cases received irradiations of 40 to 70 mr. After the irradiation, a transient increase in the total leukocyte count due to increase of neutrophil cells within 24 hr, or a transient increase in lymphocytes after 24 hr was observed in most cases. In cases where the neutrophil cell count remained nearly unchanged or decreased, the lymphocyte count was found increased, but in cases where the lymphocyte count remained unchanged or decreased, the neutrophil cell count was found increased. When the same individual was exposed to irradiation of the same quantity on different occasions, the resultant changes in his blood picture or the time of the appearance of the changes were varied. The grade of the reactions in blood pictures was not proportional to the quantity of the total irradiation. In the cases exposed to scattered x rays for the first time, the changes in the total leukocyte count and neutrophil cell count were larger than the blood changes of the professional radiological workers exposed to scattered x rays for a long time. (Absts. Japan. Med., 1: No. 7, 1960.)

22108 EFFECTS OF WHOLE BODY X-IRRADIATION ON IRON METABOLISM. I. Miyata (Nagoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2126-33(1960).

Serum iron (SI) and percent-utilization of radioactive iron by the erythrocytes were determined following single and daily whole-body x irradiation in varying doses to male rabbits. SI and unsaturated iron binding capacity (UIBC) of x-ray technicians were measured in 1953 and 1957. Transient decrease of SI was observed from 6 to 24 hr and the lowest value appeared at 12 hr after the single x irradiation; thereafter, SI reached its maximum at 48 or 72 hr. The greater the single dose, the more marked was the fluctuation of SI. Daily exposure to x rays for 4 weeks caused a gradual increase of SI in the animals which received more than 12.5 r, and the greater the daily doses, the more marked the increase of SI. The elevated level of SI began to decrease after the suspension of daily irradiation for 4 weeks, and the greater the doses, the slower the recovery from the increased SI. Decrease of percent-

utilization of radioactive iron by erythrocytes was marked after the single as well as after the daily irradiation. Effects of daily exposure to a small dose of x rays were similar to those of a greater dose of single irradiation. The increase of SI and decrease of percent-utilization of radioactive iron would be due to the obstruction of hematopoiesis following whole-body x irradiation. Trends of increase of SI and decrease of UIBC of x-ray technicians were observed in 1953. Differences in SI and UIBC between x-ray technicians and normal control persons were insignificant in 1953 and 1956. (Absts. Japan. Med., 1: No. 7, 1960.)

22109 STUDIES ON THE COMBINED EFFECT OF IR-RADIATION AND VARIOUS CHEMICALS ON MITOTIC CELLS. XVII. EFFECTS OF COMBINED USE OF MITOMYCIN C AND X-RAYS. H. Sasaki (Hokkaido Univ., Sapporo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2134-45(1960).

The MTK sarcoma III of a rat, 3 to 4 days after transplantation was adopted as material for this study. Mitomycin C was injected into the peritoneal cavity of the rat. The effect was judged by the frequency of mitosis, the difference of each mitotic phase in number, the frequency of abnormalities of chromosomes in the metaphase and the anaphase, and the life span of the tumor-bearing rat. Mitomycin C in the amount of 0.001 to 0.1 mg/100 g caused a decrease of mitotic cells at 3 hr after its injection. Mitotic cells became fewest at 6 hr after injection, and after that they gradually increased in number. Rapid decreases in the number of mitotic cells were caused by 0.3 mg/100 g of the drug; all the cells disappeared at 48 hr after injection. The mitotic cells in each phase decreased in proportion to the mitotic index. Mitomycin C influenced both resting and dividing tumor cells. In the resting cells, vacuoles were formed in the cytoplasm following the change which occurred in the nucleus, and finally the cells were destroyed. In the dividing cells, stickiness or condensation of chromosomes was noticed; then, such abnormalities as breakage of chromosomes, formation of chromosomal bridges, or coalescences appeared. Injection of 0.01 mg/100 g of mitomycin C right after or 1 hr after x irradiation showed a much stronger effect in decreasing the mitotic cells of the sarcoma than either radiation or drugs alone. The combined effect in decreasing the mitotic cells of the sarcoma was increased further when injection of 0.01 mg/100 g mitomycin C was carried out before irradiation. Even a very small amount of mitomycin C, 0.001 mg/100 g, increased the effect in the combined use. The combined use of mitomycin C with x rays brought about an increase in the life of a tumor-bearing rat; 0.05 mg to 0.3 mg/100 g of the drug depressed the tumor almost completely, 0.01 mg/100 g also prolonged the life of the tumor-bearing rat, though the effect was less than in the former case. (Absts. Japan. Med., 1: No. 7, 1960.)

22110 PERIPHERAL BLOOD PICTURE OF RATS INJECTED WITH RADIOACTIVE STRONTIUM INTRAPERITONEALLY. T. Yamaguchi (Nagoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2167-80(1960).

Adult male rats were injected with radioactive strontium into the peritoneal cavity. Normal average blood counts were obtained from 10 healthy adult male rats. RBC $(821 \pm 78) \times 10^4$, WBC 10900 ± 3067 , basophils $0.05 \pm 0.16\%$, eosinophils $1.05 \pm 0.72\%$, neutrophils $20.1 \times 6.58\%$, lymphocytes $77.4 \pm 6.87\%$, and monocytes $1.5 \pm 0.71\%$ (mean values with confidence limits). As the blood for the examination was obtained by cutting the rats' tails, it was feared that a change in the blood picture might be caused

by the blood loss. A control examination made clear that this procedure scarcely influenced the blood picture except for a slight temporary leukocytosis 6 hr after cutting the tail. In the rats injected with $150 \mu\text{C}$ of Sr^{90} a slight temporary anemia was observed one week after the injection, but the animals injected with $5 \mu\text{C}$ and $0.5 \mu\text{C}$ of Sr^{90} showed no anemia. Initial leukocytosis was seen 6 to 24 hr after the injection, followed by slight to moderate leukopenia until about the second week. A recovery to the normal level was then seen in the group injected with 5 and $0.5 \mu\text{C}$ of Sr^{90} , while no recovery resulted in the rats injected with $150 \mu\text{C}$ of Sr^{90} , even after the 5th week. Initial leukocytosis was presumably due to both radiation injury and repeated bleeding from cutting the tail. In the rats injected with $0.5 \mu\text{C}$ of Sr^{90} no significant decrease of neutrophils was recorded throughout the experiment. Sr^{90} -injected animals did not show a complete recovery of lymphopenia even in the 5th week, while in the Sr^{90} -injected rats relatively faster recovery was observed although some initial lymphocytosis was present. Eosinophils showed a similar course of change to the lymphocytes with more exaggerated variations than lymphocytes. Monocytes were generally decreased in number until the recovery about 1 to 2 weeks after the injection, except for the Sr^{90} -injected rats which showed no tendency to recover even after the 5th week. In each group neutrophils appeared to shift to the left immediately after the injection. These results are discussed in relation to the internal radiation dose calculated in the bone marrow of each group. (Absts. Japan. Med., 1: No. 7, 1960.)

22111 STUDY ON CHEMICAL PROTECTION AND RESTORATION AGAINST RADIATION DAMAGES. III. EFFECT OF α -THIOCTIC ACID. M. Ozeki, N. Nagata, S. Yanase, B. Nakamura, and R. Mori (Kurume Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2181-4(1960).

α -Thioctic acid (0.5 to 1.0 ml) was injected into rats and mice to evaluate its effects on the recovery from radiation sickness based on the survival rate and blood picture. In the survival test, α -thioctic acid decreased the death rate significantly; its effectiveness was intensified when the agent was given before irradiation rather than after irradiation. The α -thioctic acid also inhibited a decrease of the body weight and decreased blood injuries. (Absts. Japan. Med., 1: No. 7, 1960.)

22112 EXPERIMENTAL STUDIES ON THE FRACTIONAL IRRADIATION OF RABBIT SKIN. N. Yamamoto (Showa Medical Coll., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 2185-2205(1960).

The shaved skin of rabbits were irradiated with daily doses of 300 r and irradiations were continued until 1500 r to 9000 r in total had been given. Macroscopic and microscopic observations showed early erythema developed in every case, 5 to 6 days from the beginning of irradiation. This erythema faded in 10 to 16 days even in the cases to which irradiation was being continued. Main erythema became manifest when more than 3000 r had been administered. Its time of appearance and duration was proportional to the dose administered. Epilation and baldness occurred over 3000 r and 6000 r, respectively. These findings corresponded to the histological change of hair follicles. The excoriation was different in nature within their border line in the vicinity of 4500 r. Acute erosion occurred in the case of irradiation of more than 6000 r and its findings were well in accordance macroscopically and microscopically. Up to 3000 r, hair was able to recover completely, but permanent baldness occurred over 7500 r. Recovery of epidermis

had taken place below 6000 r when examined histologically, thickening at 7500 r and chronic ulceration in more than 7500 r were found. It was noteworthy that almost all of these findings coincided both macroscopically and microscopically. (Absts. Japan. Med., 1: No. 7, 1960.)

22113 EFFECT OF X-IRRADIATION ON THE DIGESTIVE SYSTEM. I. INFLUENCES OF X-IRRADIATION ON THE METABOLISM OF RATS. S. Han, K. Nagasawa, and H. Nanba (Osaka Medical Coll.). Nippon Yakurigaku Zasshi, 54: 1361(1958).

In rats exposed to whole-body x irradiation of 500 r, the weight of the digestive tract tissues gradually decreased, especially that of the small intestine. This returned to approximately normal after 6 to 8 days. In rats receiving both whole-body x irradiation of 500 r and partial exposure of 100 r over the adrenal region, the weight of the digestive organs increased. In rats treated with DNP or ATP before total-body irradiation, the results were similar. (Abstr. Japan. Med., 1: No. 1, 1960)

22114 EFFECT OF 2:4-DINITROPHENOL AND ADENOSINE TRIPHOSPHATE ON THE METABOLISM AFTER X-IRRADIATION. IV. INFLUENCE OF X-IRRADIATION ON METABOLISM IN RATS. S. Han, M. Yanagawa, and H. Nanba (Osaka Medical Coll.). Nippon Yakurigaku Zasshi, 54: 1371(1958).

After x irradiation a decrease of the glycogen content of the liver and an appreciable reduction of glycogen uptake in the leg muscles were usually observed. However, in the group repeatedly given 2:4-dinitrophenol these changes were absent. Administration of adenosine triphosphate was also used therapeutically. An appreciable effect, however, appeared only in the case of pretreatment. (Abstr. Japan. Med., 1: No. 1, 1960)

22115 EFFECT OF SINGLE X-RAY IRRADIATION ON SERUM PROTEIN AND NITROGEN. II. EFFECT OF SINGLE X-IRRADIATION ON BLOOD COMPONENTS. M. Yoshida (Tokyo Medical and Dental Univ.). Ochanomizu Igaku Zasshi, 7: 970-4(1959).

In rats exposed to single doses of x irradiation of 600 r, serum nitrogen and protein were analyzed. Total serum nitrogen, protein-nitrogen, and total protein were not much influenced by x irradiation. However, non-protein-nitrogen in serum appeared moderately increased after irradiation until the 9th day. Then it decreased slightly. Paper electrophoresis showed some decrease of pre-lysine groups and a definite increase of amino-acid components on the 3rd day after irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22116 EFFECT OF SINGLE X-RAY IRRADIATION ON SERUM Na, K, AND Cl. III. EFFECT OF SINGLE X-IRRADIATION ON BLOOD COMPONENTS. M. Yoshida (Tokyo Medical and Dental Univ.). Ochanomizu Igaku Zasshi, 7: 974-8(1959).

The effect of x irradiation on serum Na, K, Na/K, and Cl in rats exposed to a single x-ray dose of 600 r was studied. Serum Na level was decreased about 2 days after irradiation, but returned to approximately normal about 7 days later. Serum K decreased even more than Na after irradiation. Thus, the Na/K ratio was slightly elevated. However, this returned to normal after about 21 days. The serum Cl level changed as did the Na level. (Abstr. Japan. Med. 1: No. 1, 1960)

22117 EXPERIMENTAL STUDY ON THE GENESIS OF RADIATION HAZARD. I. THE HISTOCHEMICAL CHANGES OF BLOOD CORPUSCLES BY IRRADIATION. M. Yamamoto, S. Nishishita, R. Ando, S. Nobuki, I. Tukamoto, T. Hashigami, K. Akagi, M. Wakimoto, and K. Yamamoto (Oka-

yama Univ., Japan). Okayama Igakkai Zasshi, 71: 2393-8 (1959).

On the hypothesis that a toxic substance is induced by irradiation, rabbit's blood cells were studied histochemically for the presence of a toxic substance. When the blood cells were damaged, the white blood cells were irradiated with successive doses of 300 r Freifeld toxic granules appeared, at a total dose of 1200 r (4×300 r) to the extent of 100%. Scharlach granules then appeared and a longer time was necessary to reach 100%. Therefore, the number of Scharlach granules was taken as an indication of the degree of damage. As the white blood cells decreased, the various toxic granules increased. After injection of P^{32} , the Scharlach granules began to appear after 2 hr, but it took 48 hr to reach 100%. (Absts. Japan. Med., 1: No. 7, 1960.)

22118 EXPERIMENTAL STUDY ON THE GENESIS OF RADIATION HAZARD. II. INDUCED ANAEMIA. M. Yamamoto, S. Nishishita, R. Ando, S. Nobuki, S. Kojima, J. Tanimoto, K. Akagi, and T. Shiaku (Okayama Univ., Japan). Okayama Igakkai Zasshi, 71: 3193-6(1959).

On the basis of a hypothesis that a certain toxic substance was produced in the blood stream by x irradiation and caused secondary damage, the effect of blood irradiation in the test tube by x rays and Co^{60} γ rays was studied after transfusion to healthy rabbits. When non-irradiated blood was transfused for 6 days, white and red cells and hemoglobin were increased; the degree of hemolysis was not altered and red cells with Heinz' bodies did not appear. However, after transfusion of the blood irradiated in the test tube with a dose of 3000 r, the red and white blood cells and hemoglobin were decreased, red cells including Heinz' bodies appeared, and the degree of hemolysis increased. These results suggested that some toxic substance was produced in the blood by irradiation and accelerated the secondary damage. The correlation between the function of RES and the appearance of the Heinz body in the blood was discussed. (Absts. Japan. Med., 1: No. 7, 1960.)

22119 SEROLOGICAL STUDY OF RADIATION HAZARD. I. X-RAY EFFECT ON PASSIVE ALLERGY. S. Murakami (Okayama Univ., Japan). Okayama Igakkai Zasshi, 71: 3371-80(1959).

X-ray effects on passive allergy induced by albumin antibodies in guinea pigs were studied. When a dose of 200 r was administered the lethal tendency was mostly inhibited up to 5 to 7 days after irradiation. After 14 days it was about the same as the control group, and after 28 days it was increased. When 200 r was given, a latent period up to the typical shock appeared and the time before death by shock occurred showed a tendency to increase. The degree of decrease of complement body was not clearly explained. The extent of the drop in body temperature was unequivocal. The extent of lung expansion was related to the survival rate and excessive expansion resulted in death. At 7 days after 200 r irradiation, the lung expansion was medium. The severe clinical symptoms were not seen on the 7th day after irradiation and were about the same as on the 5th day. Those of the 14th, 21st, and 28th days were relatively severe. The effect of irradiation at the dose of 100 r was not marked but those of 50 and 25 r were increased. (Absts. Japan. Med., 1: No. 7, 1960.)

22120 SEROLOGICAL STUDY OF RADIATION HAZARD. II. THE EFFECT OF X-RAY TO PASSIVE SKIN ALLERGY. S. Murakami (Okayama Univ., Japan). Okayama Igakkai Zasshi, 71: 3381-92(1959).

White albumin, dissolved in potassium alum solution in

a concentration of 1.5 mg/ml was used as antigen, and was injected into the ear vein of a rabbit every other day for 12 times. The whole blood was removed on the 7th day following the last injection, and the separated blood serum was kept in an ice box after the addition of merzonin in the proportion of 1:10000. The irradiated guinea pigs were injected with the rabbit's serum and were injected again with various concentrations of antigen into the abdominal skin after 24 hr. The skin reaction was examined a day later. After sensitization, 1.5 ml of 0.5% Evans blue solution per kg in weight was injected and immediately 0.1 ml of 1.0, 0.1, 0.01, and 0.001% of antigen was injected subcutaneous in the abdomen, 30 min after which the state of skin reaction was studied. Arthus phenomenon was mostly inhibited on the 7th day after 200 r of x irradiation, and was gradually recovered and showed slightly increased tendency on the 28th day. The area of skin reaction in Arthus phenomenon was minimum on the day following 200 r and showed increased tendency on the 28th day. After 400 r the Arthus phenomenon was mostly inhibited on the 7th day and the area of skin reaction became almost absent. Arthus phenomenon indicated by the Evans blue method showed a maximum area of skin reaction on the 7th day after 200 r, which was diffusely infiltrated with an unsharp margin and then gradually became small and sharply demarcated on the 28th day. The histological changes of the skin in the guinea pig following 200 r were slight with atrophy of the epithelium and no other changes seen. (Absts. Japan. Med., 1: No. 7, 1960.)

22121 SEROLOGICAL STUDY OF RADIATION HAZARD. III. THE X-RAY EFFECT TO ANTI-ALLERGY BY THE FORSSMAN ANTIBODY. S. Murakami (Okayama Univ., Japan). Okayama Igakkai Zasshi, 71: 3393-3402 (1959).

The x-ray effect on the anti-allergy phenomena in the guinea pig produced by the Forssman antibody, a specific form of allergy, was studied. Anti-allergy due to a Forssman antibody in guinea-pigs was inhibited by 200 r whole-body x irradiation. The minimum lethal dose range was maximum in 2 weeks after irradiation and returned to normal in 3 weeks. The latent period before the typical shock and the time of shock death were delayed. The lung weight was decreased. A 100 r irradiation did not give the same effects as a 200 r irradiation, but the same tendency was observed. (Absts. Japan. Med., No. 7, 1960.)

22122 ULTRAVIOLET LIGHT INDUCED LINKING OF DEOXYRIBONUCLEIC ACID STRANDS AND ITS REVERSAL BY PHOTOREACTIVATING ENZYME. Julius Marmur and Lawrence Grossman (Brandeis Univ., Waltham, Mass.). Proc. Natl. Acad. Sci. U. S., 47: 778-87 (June 1961).

The irradiation of DNA in solution with ultraviolet light with doses approximating those used for the inactivation of transforming activity causes the irreversible hydrogen-bond breakage, most likely in internal regions of the DNA molecule and the formation of formamide- and heat-stable linkages between the two complementary DNA strands. Repair of the latter damage is catalyzed by the photoreactivating enzyme from bakers' yeast. The cross-links are in keeping with the observations of others on the irradiation of thymine in the frozen state and may be due to the formation of dimers of thymine. (auth)

22123 TYPES AND FREQUENCIES OF HUMAN CHROMOSOME ABERRATIONS INDUCED BY X-RAYS. Ernest H. Y. Chu, Norman H. Giles, and Kari Passano (Yale Univ., New Haven). Proc. Natl. Acad. Sci. U. S., 47: 830-9 (June 1961).

Qualitative and quantitative analyses were made of x-ray-induced chromosome aberrations in human euploid cells grown in culture. Two major categories of aberrations, chromatid and chromosome, are present in irradiated cells. Chromatid types constitute the only aberrations in cells observed shortly after irradiation; chromosome types begin to appear and finally completely replace the former in successively later post-irradiation periods. A general decrease in radiosensitivity occurs in conjunction with this temporal shift in the appearance of aberration types. Quantitative results for both the chromatid and chromosome aberration types indicate that, in general, terminal deletions increase linearly with dose, whereas exchanges exhibit an exponential relationship. The frequency of spontaneous aberrations, which are almost exclusively one-hit chromatid types, is on the average 0.1 aberrations per cell in all postirradiation periods. The induced frequency at the most radiosensitive period of the cell, which follows the period during which the chromosomes become effectively double, is 0.02 aberrations per cell per roentgen. Such cells are about 5 times more sensitive than cells at interphase when chromosomes are effectively single. The coefficient of chromosome aberration production by x rays in human somatic cells is shown to be not significantly different from that in certain plant cells. This conclusion supports the view that the mechanics of chromosome aberration production by radiation are similar in both plant and mammalian cells. However, this result cannot be taken to mean that radiosensitivity, in terms of genetic damage, mutation production, and cell killing, is necessarily the same in plant and mammalian, especially human, cells. (auth)

22124 SOME EFFECTS OF TRITIATED THYMIDINE AS A DEOXYRIBONUCLEIC ACID LABEL IN THE RAT LIVER. Joseph Post and Joseph Hoffman (Goldwater Memorial Hospital, Welfare Island, New York). Radiation Research, 14: 713-20 (June 1961).

A labeling dose of tritiated thymidine (approximately 2 μ c/gm body weight) produces changes in the ploidy classes of the liver cell nuclei of the 3-week-old rat within 24 hours. Two weeks after its administration the ploidy classes are changed further and are similar to those of the 2-year-old control. Histological evidence of cellular injury is limited to cytoplasmic vacuolization and reduction of RNA during the first 2 days after tritiated thymidine. Radiation resistance appears to develop in the liver within 2 weeks after the initial exposure period. The ploidy changes appear to represent an early stage in the spectrum of alterations after irradiation, and their study offers a useful method in the investigation of the effects of radiation on cells. In the use of radioactive labeling materials for metabolic studies, the internal radiation so introduced may alter the biological system under investigation. (auth)

22125 SULFHYDRYL GROUPS AND THE OXYGEN EFFECT ON IRRADIATED DILUTE SOLUTIONS OF ENZYMES AND NUCLEIC ACIDS. Franklin Hutchinson (Yale Univ., New Haven). Radiation Research, 14: 721-31 (June 1961).

DNA irradiated in cells has previously been shown to be more sensitive in the presence of oxygen. It is shown that enzymes in cells are similarly three times as radiosensitive under oxygenated conditions. A paradox then arises, since dilute solutions of enzymes and of DNA have been repeatedly shown to be without an oxygen effect, yet much of the radiation inactivation in a cell is caused by radical attack. It is shown that the radiosensitivity of DNA in preparations of lysed cells is oxygen-dependent. Furthermore, dilute solutions of DNA and of trypsin show an oxygen effect

when SH-containing compounds are added. Possible mechanisms for the oxygen effect are discussed in light of these results. (auth)

22126 MECHANISMS OF RESISTANCE AND REVERSAL IN THE INITIAL RADIATION RESPONSE IN THE CHICK. S. P. Stearner, S. A. Tyler, M. H. Sanderson, and E. J. B. Christian (Argonne National Lab., Ill.). *Radiation Research*, 14: 732-47(June 1961).

The comparison of split, fractionated, and protracted x-ray exposures on radiation mortality in the chick indicated the presence of qualitatively different processes operating between and during irradiations. Preliminary results suggested that a nonlinear process was the likely action between doses and that the induced resistance to subsequent irradiation might be dependent on the magnitude of the initial exposure. Further studies of the kinetics of processes operating both between and during exposures were carried out by using a challenging exposure as the technique for appraisal. Assessment of the differences between reversal and resistive processes is considered in so far as it contributes information concerning the mechanisms associated with the initial radiation response. Relationships between dose and time for mortality occurring after 2 days indicate that additional injury mechanisms contribute to the acute radiation sequelae. (C.H.)

22127 LIPID MOBILIZATION IN X-IRRADIATED RABBITS. E. E. Elko and N. R. Di Luzio (Univ. of Tennessee Medical Units, Memphis). *Radiation Research*, 14: 760-6(June 1961).

The effects of lethal total-body x irradiation on various plasma lipid fractions and the degree of peripheral lipid mobilization were investigated in rabbits. Peripheral lipid mobilization was measured by the decrease in lipid concentration of a characteristic fat depot and the plasma free fatty acid response. Plasma phospholipid, free and ester cholesterol, and triglycerides were significantly increased after x irradiation. However, plasma free fatty acids were unaltered. A similar degree of lipid depletion from the adipose depot was noted in both control and x-irradiated animals, denoting that increased peripheral lipid mobilization was not a factor in the etiology of postirradiation hyperlipemia. (auth)

22128 RADIATION-INDUCED MITOTIC STIMULATION. Allen P. James and Ilse Müller (Atomic Energy of Canada Ltd., Chalk River, Ont.). *Radiation Research*, 14: 779-88 (June 1961).

Significant increases in rate of mitosis were found to follow treatment of yeast cells with acute doses of either x rays (500 r) or ultraviolet light (200 ergs/mm²). Mean generation time was decreased by as much as 14% over a period of three generations. The stimulation was detected in the generations after the second post-irradiation division of cells. From the observations it was concluded that the increase in mitotic activity is an effect of the radiation on the cells and is not due to changes in the irradiated medium. The stimulus is transmitted to successive cells but is not a result of mutation. There is a correlation between length of inhibitory period and degree of later stimulation. However, results of tests suggest that the inhibition does not bear a causal relationship to the stimulus; cells are stimulated when inhibitory influences are absent. (auth)

22129 RADIATION EFFECTS ON NUCLEAR RIBONUCLEIC ACID OF EHRLICH ASCITES TUMOR CELLS. Eberhard Harbers (Universität, Göttingen, Ger.). *Radiation Research*, 14: 789-95(June 1961).

Two types of RNA from nuclei of Ehrlich ascites tumor

cells were fractionated by ion-exchange chromatography. *In vitro* irradiation of the cells caused a change in the chromatographic profile of the nucleolar RNA. The observed radiation effects are influenced by the availability or lack of free SH groups. (auth)

22130 RADIATION INACTIVATION OF VACCINIA VIRUS. Dwight E. Wilson (Rensselaer Polytechnic Inst., Troy, N. Y.). *Radiation Research*, 14: 796-802(June 1961).

Radiation inactivation of P³²-labeled vaccinia virus indicates that the virus possesses one or two sites which are responsible for attachment to the host cell. The sensitive volume of the attachment site was found to correspond to a molecular weight of about 3 million. The sensitive volume of the unit controlling pock formation by vaccinia was found to be equal to 4% of the nucleic acid volume of the virus. The implications of the ratio of the nucleic acid volume to radio-sensitive volume are discussed. (auth)

22131 THE EFFECT OF OXYGEN AND SOME OTHER GASES ON THE RADIATION SENSITIVITY OF DRY TRYPSIN. Franklin Hutchinson and Erica Watts (Yale Univ., New Haven). *Radiation Research*, 14: 803-12(June 1961).

The effect of oxygen on the radiosensitivity of dry trypsin was measured under a variety of conditions. The way in which the sensitivity varies with pressure was measured. A maximum increase of 2.6 is found, and at 15 mm pressure of oxygen the sensitivity is halfway between the anoxic and maximum radiosensitivities. Experiments show that the effect cannot be caused by reactive species formed directly in the gas. Other experiments tended to rule out the possibility that peroxides formed on one molecule by the action of radiation attacked a second molecule when the samples were redissolved for assay. The oxygen effect was shown to decrease both with increased dose rate and with physical size of sample, probably owing to decreased oxygen concentration within the samples during irradiation. Nitric oxide also enhances the radiosensitivity of dry trypsin, but to a lesser extent. Nitrous oxide produces no change in the magnitude of the oxygen effect. (auth)

22132 MODIFICATIONS IN THE SUPERSTRUCTURE OF FIRST ORDER CELLULES OF THE RENAL TUBE OF THE KIDNEY IN X-IRRADIATED RATS. A. Santoro and U. Nuvolone (Università, Messina, Italy and Ospedale Maggiore, Novara, Italy). *Radiobiol. latina*, 3: 279-300 (Oct.-Dec. 1960). (In Italian)

An electron microscopic study of the early alterations of the cells of a first order renal tubule in rats submitted to a single dose of 2000 r of x radiation in the renal area has shown for the first time that ionizing radiations can induce reversible cellular modifications in a few hours; these modifications can be detected within five minutes after the irradiation. A discussion of the results led to the conclusion that the modifications observed must be considered the result of the general action of the radiation on living tissue and not specific to the renal tissue. (auth)

22133 ASCORBIC ACID AND IRRADIATION. I. THE VARIATIONS OF ASCORBIC ACID AND DEHYDROASCORBIC ACID IN IRRADIATED GUINEA PIGS. A. Billiteri and G. Gasso (Università, Catania, Italy). *Radiobiol. latina*, 3: 301-18(Oct.-Dec. 1960). (In Italian)

The behavior of ascorbic and dehydroascorbic acids in the blood or organs of irradiated guinea pigs was studied. In the blood a progressive diminution in vitamin C content was observed. Moreover, this diminution was apparent during the first five hours after irradiation and affected the oxidized form earlier than the reduced form. In the tissues, changes in vitamin C content occur in three phases:

at first (1 to 2 hours) there is a sharp fall which is followed by a return to normal or even raised values in certain organs (5 hours to 6 days); finally the content diminishes again (in the adrenals, brain, spleen, gonads after 3 to 8 days). It is the reduced form of ascorbic acid which usually accounts for the variations in the organs; in the spleen, however, the oxidized form increases appreciably. It was observed finally that post-irradiation atrophy of the spleen and gonads is not associated with any diminution in their capacity to fix ascorbic acid, of which the content in mg/g remains constant. (auth)

22134 CONSIDERATIONS ON THE HISTOCHEMICAL AND HISTOLOGICAL MODIFICATIONS INDUCED BY IONIZING RADIATIONS IN PAROTID CELLS OF EPIMYS NORVEGICUS VAR. ALBINA ERXL. E. Caffaratti and A. C. Levi Università, Turin). *Radiobiol. latina*, 3: 319-30 (Oct.-Dec. 1960). (In Italian)

The histological and histochemical changes in the serous cells of the parotid gland in rats of the species *Epimys norvegicus* var. *albina* (Erxl) following treatment with inhibitory doses of x rays and, in some cases, subsequent stimulation with pilocarpine were studied. The results observed may be summarized as follows: a considerable reduction after irradiation of the DNA, frequently accompanied by a relative increase in that RNA fraction which is connected with cell metabolism and situated outside the ergastoplasm and nucleolus. By contrast the relative amount of RNA associated with the secretory function of the cell diminished considerably and this diminution was always accompanied by absence of a well-defined ergastoplasm and lack of a demonstrable nucleolus. This response of the nucleic acids, which was a little less marked in the animals stimulated with pilocarpine before death, was already clearly evident 60 minutes after irradiation and appeared most marked between the 5th and 8th day. During the 5 days after irradiation a few of the cells presented a preprophase-like appearance: they were larger and very rich in chromatin. The opposite responses to radiation of the two fractions of RNA according to their different metabolic activities re-affirm that radiosensitivity must be conceived on a functional basis related to the metabolic state at the time of irradiation. The preprophases observed in a small number of cells during the 5 days following irradiation seem, by contrast, to underline the ways in which the phenomenon is manifest, by a stimulating effect due to the indirect action (in the wider sense) of the radiation without this involving an increase in the energy level of the part of the metabolic system concerned. (auth)

22135 IMMUNITARY VARIATIONS IN ANIMALS IRRADIATED DURING HIBERNATION. V. BEHAVIOR OF ANTIBODIES. A. Billitteri and G. Gasso (Università, Catania, Italy). *Radiobiol. latina*, 3: 341-6 (Oct.-Dec., 1960). (In Italian)

The anti-typhoid agglutination titre in guinea pigs immunized with anti-typhoid vaccine and irradiated during hibernation was established. Compared with ordinarily irradiated controls, they found much higher agglutination titres. (auth)

22136 OSCILLATIONS OF THE NUCLEAR SIZES OF CELLS OF THE ADRENAL CORTEX IN RATS FOLLOWING IRRADIATION OF THE CORTEX AND OF THE PELVIS. M. Basile, G. Lo Sardo, U. Nuvolone, and A. Trenta (Università, Messina, Italy; (Università, Pavia; Italy and Ospedale Maggiore, Novara, Italy). *Radiobiol. latina*, 3: 347-62 (Oct.-Dec. 1960). (In Italian)

The nuclear volume was studied in the zones of the adrenal cortex of rats whose adrenals had been irradiated directly

and in rats in which the pelvis, but not the adrenals themselves had received a dose of 2000 r; the rats were sacrificed 5 hours, 24 hours, 5 days, and 30 days after irradiation. The following conclusions were drawn: ionizing radiation, whether administered directly to the adrenals or to the pelvis (but not the adrenals), gives rise to an increase in nuclear volume in all zones of the cortex; the increase is more pronounced in the outer zona fasciculata than in the zone reticularis. As already concluded by other authors, they affirm that increase in nuclear volume is the morphological expression of hyperactivity of the gland. After irradiation of the pelvis the neuro-endocrine effect produced by stress should predominate; after direct irradiation this effect should be partially neutralized by direct radiation damage. For this reason, increase in nuclear volume was more pronounced (especially in the zona fasciculata) in animals in which the pelvis had been irradiated and became more obvious 5 and 30 days after irradiation. (auth)

22137 THE EARLY SUPERSTRUCTURAL MODIFICATIONS IN THE LIVER OF RATS FOLLOWING LOCALIZED IRRADIATION WITH GAMMA RAYS (Co^{60}). A. Santoro and S. Greco (Università, Messina, Italy and Università, Catania, Italy). *Radiobiol. latina*, 3: 363-82 (Oct.-Dec. 1960). (In Italian)

By means of the electron microscope the ultrastructural changes in hepatic cells of rats exposed to 1000 and 2000 r of gamma radiation were studied. The modifications appear in a short time (few seconds). They are not specific of hepatic parenchyma and do not depend on the dose. (auth)

22138 INVESTIGATION ON THE CHANGES IN THE THERMAL RESISTANCE OF ERYTHROCYTES FOLLOWING WHOLE-BODY IRRADIATION. G. Baldini and G. L. Buraggi (Università, Milan). *Radiobiol. radioterap. e fis. med.*, [3] 16: 25-32 (1961). (In Italian)

The thermal resistance of the erythrocytes of rats exposed to whole-body irradiation with single doses corresponding to the lethal dose was studied. The studies were made on the blood of 64 animals. The results obtained show a marked lowering of the total thermal resistance in the first hour following the irradiation. In 24 hours the values have almost returned to normal and are maintained, with internal oscillations from the mean values found in the controls, up to the twentieth day. Possible hypotheses to explain the results are discussed. (tr-auth)

22139 THE LETHAL EFFECT OF ^{60}Co γ -RAYS ON GROWING HEN'S EGG. Toyoji Matsumoto (Okayama Univ., Japan), Masahiro Kiyoto, Yasuhiro Kanemasa, Yutaka Kusai, and Sukenobu Kawasaki. *Radioisotopes (Tokyo)*, 8: 52-5 (Mar. 1959). (In Japanese)

The lethal effect of cobalt-60 gamma rays on hen's eggs for periods of 5, 10, 15, and 20 days incubation was determined. The doses of radiation given were 100, 200, 400, 600, and 800r. Regarding the eggs hatched as survivors, it was calculated that the medial lethal dose of gamma rays is 108r for 5 days egg, 237r for 10 days, 458r for 15 days, and 800r for 20 days. Hence, the eggs are more seriously affected in the early stages. (N.W.R.)

22140 THE EFFECT OF ^{60}Co RADIATION ON THE GROWTH OF TRICHOMONAS VAGINALIS. Taiichi Ito and Masahiko Fukaya (Niigata Univ., Japan). *Radioisotopes (Tokyo)*, 8: 56-64 (Mar. 1959). (In Japanese)

Cultures of *trichomonas vaginalis* were placed on platinum plates containing 2.3, 1.0, and 0.9 mc of Co^{60} , placed in an incubator, and the number counted at various times. *Trichomonas* have a high susceptibility to gamma radiation. Growth was inhibited, and when transplanted to a new

medium, the growth rate was slow in returning to normal. Repeated irradiations and transplantations indicated no acquired radiation resistance. (N.W.R.)

22141 STUDIES ON MECHANISM OF BACTERICIDAL ACTION BY IRRADIATION WITH RADIOISOTOPE COBALT-60. Takehiko Akimoto (Keio Gijuku Univ., Japan). Radioisotopes (Tokyo), 9: 6-16 (Apr. 1960). (In Japanese)

E. Coli, YC-1 strain, were subjected to 40-C irradiation under various conditions and the survival ratios measured. The following results were obtained: With radiation dosage held constant, prolonged irradiation produced less bactericidal effect. Temperature and environment before irradiation had little influence on the bactericidal effect. Pre-irradiation washing had little effect. In the earlier stage metabolism continued but gradually decreased later. The more densely the suspension is populated, the higher the survival ratio. This ratio is decreased when a large number of bacteria is treated with a sublethal dose of streptomycin before irradiation. Treatment with chloramphenicol showed no effect in a small population, but the survival ratio decreased in a large population. Penicillin caused a decrease in a large population also, but in a small population the ratio became markedly high. It is presumed that the activity of bacterial metabolism is closely related to the bacterial action of irradiation. (P.C.H.)

22142 STUDIES ON THE INFLUENCE OF RADIOACTIVE-RAYS UPON THE HEMOCYTES OF THE SILKWORM, BOMBYX MORI, L. IV. ON THE SEXUAL DIFFERENCES BETWEEN THE EFFECTS OF THE INGESTED RADIOISOTOPES ON THE NUMBER OF HEMOCYTES OF THE SILKWORM. Toshioki Gamo, Hisao Nishiyama, and Shigeo Midorikawa (Shinshu Univ., Japan). Radioisotopes (Tokyo), 9: 17-24 (Apr. 1960). (In Japanese)

Attempts were made to show some sexual differences in the destructive influences of radiation upon the numbers of hemocytes of the silkworm. Just moulted silkworm larva of the fifth stage were administered 0.1 cc of 0.5% solution Ca^{45}Cl or 0.3% solution of $\text{H}_3\text{P}^{32}\text{O}_4$ through the mouth. It was concluded from the results that the largest damage of Ca^{45} and P^{32} was inflicted on the proleucocyte, especially in the male silkworm. (P.C.H.)

22143 STUDIES ON THE EFFECTS OF RADIATION ON CHICK EMBRYOS. II. THE LETHAL EFFECT OF INTERNAL β -IRRADIATION OF ^{32}P . Katsumoto Ueda and Kenzo Okabe (Defense Academy, Japan). Radioisotopes (Tokyo), 9: 25-32 (Apr. 1960). (In Japanese)

Radioactive phosphorus was diluted with physiological saline and injected after sterilization into yolk sacs of developing chick embryos. The injected eggs were inspected daily by candling for their viability. Dead embryos and hatched chickens were observed grossly. Survival times after injections were longer when smaller doses were administered. Growth retardations of total bodies, small size of spleens, and gonads were observed in groups receiving doses of more than 50 μC per egg. The embryos that died 1 to 2 weeks after injection showed generalized edematous change. Anomalies of beaks and hind limbs, similar to malformations produced by x radiation, were observed in some embryos which died during incubation. (P.C.H.)

22144 ULCERATIVE DERMATITIS AFTER SIEVE IRRADIATION. Y. Ueno, Y. Hidaka, and M. Hiroshige (Nippon Univ., Tokyo). Rinsho Hoshasen, 4: 675-80 (1959).

Three cases are described. The lower abdomen was irradiated for uterine cancer with 6 to 7 portals by the sieve technique. The maximum skin dose was estimated to be 9500 to 10300 r in every case. About 2 to 12 months after the ir-

radiation, ulceration associated with severe local pain developed. No tendency toward remission was noted. This dose level is not considered harmful when sieve irradiation is used. Even in sieve radiation therapy though, this dosage must be given carefully. (Abstr. Japan Med., 1: No. 8, 1961)

22145 EFFECT OF RADIATION ON DNA METABOLISM AND DESOXYRIBONUCLEASE (DNase) ACTIVITY IN TUMOUR TISSUE AND IN GENERAL TISSUE WITH CANCER. T. Sekiguchi and H. Yoshikawa (Tokyo Univ.). Rinsho Seirikagaku Shinpoizumu, 2: 63 (1959).

The investigation of DNA metabolism with P^{32} revealed that in the spleen it was very active in the initial stage and rapidly fell in the course of time, whereas in tumor tissue it was low initially but increased gradually as time elapsed and at 24 to 48 hours it reached its highest value. In the liver the activity was low. The DNase activity in the above-mentioned tissues corresponded fairly well with DNA metabolism; it was high in tumor and spleen tissues and very low in the liver. DNA metabolism was greatly suppressed in all tissues of animals after irradiation with 300 r of x rays, but the specific pattern of this metabolism in the tissues was still well reserved; the activity of DNase was stimulated by irradiation. Destruction of cell structure seemed to be one of the most important factors in this stimulation of DNase activity after irradiation. (Abstr. Japan. Med., 1: No. 1, 1960)

22146 DEAMINATION OF ADENINE BY IONIZING RADIATION. Cyril Ponnampuruma, R. M. Lemmon, E. L. Bennett, and Melvin Calvin (Univ. of California, Berkeley). Science, 134: 113 (July 14, 1961).

A small amount of hypoxanthine is formed when a solution of adenine is irradiated. This was detected by using C^{14} -labeled adenine and the techniques of paper chromatography and liquid-scintillation counting. The biological significance of this conversion is suggested. (auth)

22147 EFFECT OF COBALT CHLOROPHYLL DERIVATIVE ON X-RAY DEPIILATION IN RABBITS. M. Saito, T. Iwata, M. Suzawa, K. Shiozu, and T. Furuta (Osaka Medical Coll.). Shinyaku to Rinsho, 8: 913 (1959).

Twelve white male adult rabbits were divided into 2 groups. Into one group 5 mg of cobalt chlorophyll was injected intravenously daily beginning one week before single x irradiation of 980 to 2,000 r to the thigh. The other group, into which cobalt chlorophyll was not injected, served as the control group. After simultaneous x irradiation of both groups, it was observed that in the cobalt chlorophyll-injected group depilation appeared to be a little less than that seen in the control rabbits. (Abstr. Japan. Med., 1: No. 1, 1960)

22148 SIEVE IRRADIATION OF DEEP LESIONS. H. Kaneda and T. Hishida (Kyoto Prefectural Univ.). Sogo Kenkyuhokoku Shuroku, Ganhan, 14: 66 (1958).

The tests of rabbits placed under a paraffin block 5 cm thick were irradiated through a sieve and examined histologically after 10 weeks. The changes in seminiferous tubules were less with sieve irradiation than with ordinary irradiation. (Abstr. Japan Med., 1: No. 2, 1960)

22149 EXPERIMENTAL STUDY ON ROENTGEN CANCER (INFLUENCE OF CROTON OIL). H. Kaneda and S. Shimazaki (Kyoto Medical Coll.). Sogo Kenkyuhokoku Shuroku, Ganhan, 14: 66 (1959).

One group of rats was x rayed repeatedly up to a total dose of 32100 r with a contact x ray unit without a filter. During the period 5% croton oil was applied repeatedly to the irradiation field. Another group of rats was x rayed but croton oil was not applied. No cancer developed in the

irradiated field of the latter group even 6 months after irradiation. (Abstr. Japan Med., 1: No. 2, 1960)

22150 PHYSIOCHEMICAL STUDIES OF THE MECHANISM OF RADIATION EFFECTS ON THE CELL. IV. THE CANCER CELL. I. Honjo, A. Takeda, Y. Yakamori, and T. Maeda (Osaka Univ.). Sogo Kenkyuhokoku Shuroku, Hoshasenhen, 13: 54(1958).

Ehrlich's ascites cancer cell suspensions, obtained from implants in MA-2 mice with or without P^{32} injection, were irradiated with single doses of 1000 r of Co^{60} γ rays. The amount of K and the amount of radiation in the ascites and in several bones immediately and several hours after irradiation were measured with a flame-photometer. The amount of DPN in the cancer cell was measured after irradiation in vitro and in vivo. In the spleen the amount of DPN was measured after total body irradiation. Experiments on the effect of radiation on permeability of the cell were inconclusive. The amount of DPN in cancer cells was not influenced by radiation. The reason for this is not yet clear. (Abstr. Japan Med., 1: No. 2, 1960)

22151 RADIATION BIOCHEMISTRY. III. THE EFFECT OF RADIATION ON THE BIOSYNTHESIS OF DNA. H. Yoshikawa and T. Sekiguchi (Tokyo Univ.). Sogo Kenkyuhokoku Shuroku, Hoshasenhen, 13: 156(1958).

The most favorable conditions for the synthesis of DNA in tumor cells in vitro were studied by P^{32} experiments. Fifty μ c of P^{32} applied to 2 to 3 g of tissue was not incorporated in the synthesis of DNA after one hour. After 18 hours of incubation, P^{32} was incorporated in the synthesis of DNA to the same degree in both homogenate and sliced tissue. RNA showed 10 times greater specific activity than did DNA. (Abstr. Japan Med., 1: No. 2, 1960)

22152 THE EFFECT OF RADIATION ON NUCLEIC ACID SYNTHESIS. IV. BIOSYNTHESIS OF RNA IN BACILLUS COLI AFTER ULTRA-VIOLET IRRADIATION. K. Watanabe (Tokyo Univ.). Sogo Kenkyuhokoku Shuroku, Hoshasenhen, 13: 168(1958).

The amount of P^{32} was measured in the RNA fraction of Esch. coli exposed to uv rays and cultured in a medium containing P^{32} . Then they were subcultured in a medium without P^{32} . When the P^{32} was washed out 30 min after irradiation, unstable RNA disintegrated. This unstable RNA did not become stable even with addition of chloramphenicol or dinitrophenol or in the absence of glucose. (Abstr. Japan Med., 1: No. 2, 1960)

22153 EFFECT OF X-RAY IRRADIATION ON PROTEIN SOLUTION. T. Tachibana (Univ. of Ochanomizu, Japan). Sogo Kenkyuhokoku Shuroku, Hoshasenhen, 13: 40-1(1959).

A pure aqueous solution of albumin was exposed to x rays. It showed maximal absorption at 280 $m\mu$ in the spectrum which did not change after irradiation. However, the absorption rate appeared to change with the elapse of time after exposure. The surface pressure and area curve of the buffer solution of the irradiated protein solution were also studied. Although the essence of such changes is still unknown, the solution of this problem may be useful for decontamination of radioactivity. (Abstr. Japan Med., 1: No. 2, 1960)

22154 EFFECTS OF 'STRONG MORIAMINE S' ON LEUCOPENIA IN RADIATION THERAPY. M. Matsuda, T. Sugihara, Y. Kakehi, and A. Ijir (Kyoto Univ.). Sogo Rinsho, 8: 1557-60(1959).

Strong moriamine S, a type of amino-acid preparation, was administered intravenously to patients receiving radiation therapy. In all cases symptoms of radiation sick-

ness appeared to be moderately improved. After the injection of this agent leukopoiesis improved in 60% of the patients. Strong moriamine S is considered to be one of the effective agents for the therapy of radiation sickness and leucopenia following irradiation. (Abstr. Japan Med., 1: No. 1, 1960)

22155 COMPARATIVE STUDIES OF THE DELAYING OF ANTIBODY FORMATION BY X RAYS AND A N-MUSTARD PHOSPHAMIDE ESTER. Hans-Stephan Stender, Dieter Strauch, and Horst Winger (Universität, Marburg/Lahn, Ger. and Universität, Giessen, Ger.). Strahlentherapie, 115: 175-86(June 1961). (In German)

X-ray radiation and the N-mustard-phosphamide ester "Endoxan" (NLP), a cytostatic, prevent the antibody reaction on brucella antigens in the rat. NLP inhibits the antibody formation in essentially smaller doses than ionizing rays. A clearer sensitivity difference of each phase of the antibody formation is present with the use of x radiation, but not after the administering of NLP. Small doses of the cytostatic, contrary to x radiation after antigen dosage, can completely suppress within a few days the agglutinin formation. The attacking point of both factors lies in the cells of the lymphoreticular tissue, in which the antibodies are synthesized. (auth)

22156 EXPERIMENTS ON THE DETECTION OF SO-CALLED RADIOTOXINS. Emil H. Graul, Klaus Damminger, and Walter Rütger (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 115: 187-202(June 1961). (In German)

To study toxic substances which appear after irradiation in the organism, bacterial cultures on cultures of several days standing of animal sera were examined. The increase of the germs was clearly inhibited in the serum of radiated animals by treating the animal with Periston almost the same as the controls. When Periston was added to the serum of radiated animals in vitro, the protective action was again there, but less strongly marked. To account for the nature of the so called "radiotoxins" chemical and strong electrophoretic separations of the animal sera were carried out. It could be verified that no specific protein ingredient is the carrier of toxic components, but that the growth in albumin as well as in the α -, β - and γ -globulin of radiated animals is inhibited. The protection effect of Periston allows itself to be proved only in the globulins with a maximum in the γ -globulins. (auth)

22157 RADIOBIOLOGICAL STUDIES OF SIEVE AND RASTER IRRADIATION. I. ANIMAL EXPERIMENTS ON THE IMPORTANCE OF THE HOMOGENEITY QUOTIENT FOR THE SKIN-PROTECTIVE EFFECT OF SIEVE IRRADIATION. Ludwig Rausch (Universität, Marburg/Lahn, Ger.). Strahlentherapie, 115: 283-302(June 1961). (In German)

The importance of the homogeneity quotient for skin protections is examined as part of a larger experimental study on the radiobiology of sieve irradiation. The formal and biological aspects, which are in opposition to the radiobiological and/or radiotherapeutical interpretation of the sieve effect formula are mentioned. The experiments (carried out in 3 dose levels on the perforation-hole healing-test on the rabbit ear) concerning the protective effect of sieves with various ray permeabilities show that the experimentally found protective effect does not correspond to the values obtainable from the sieve effect formula, and that there exists an evident dependency on dose level. This is shown by a different protective effect for each dose level with the same homogeneity. From this it can be concluded,

that an interpretation of the sieve effect formula as a formula for protective effect is not permissible. (auth)

22158 CONTRIBUTION TO THE QUESTION OF SURFACE PROTECTION IN IRRADIATION WITH HIGH ENERGY ELECTRONS WITH A BETATRON. Gerd Hagemann and Eberhard Lühr (Universität, Marburg/Lahn, Ger.). *Strahlentherapie*, 115: 333-6 (June 1961). (In German)

In screening off the 17-Mev electrons of the betatron there arises in the lead absorbers a hard bremsstrahlung whose dose efficiency can amount up to 5% of the electron dose. It can be reduced to at least the half by using Al-Pb-absorbers with the same screening power. The optimal screening conditions and the dose efficiency of the bremsstrahlung as a function of the distance between the absorber in air and the tissue equivalent material are examined experimentally. (auth)

22159 EFFECT OF X-RAYS ON BONE STUDIED BY MEANS OF Ca^{45} . M. Umehara (Tokyo Medical Coll.). *Tokyo Ikadaigaku Zasshi*, 17: 839-59 (1959).

During the first 24 hours after the injection of Ca^{45} , a rapid increase of calcium accumulation in the bone was observed. When the shins of mice into which Ca^{45} was injected were exposed to 3000 to 9000 r of x rays, the calcium accumulation immediately decreased in the irradiated bone. When a small dose (300 r) was applied, no perceptible change in the calcium accumulation was observed. The uptake of Ca^{45} injected was much less in the young mice than in the mature mice. About 20 days after irradiation of 2400 r the length and weight of the tibia decreased slightly but significantly as compared with the control shins. This decrease was especially pronounced in the young mice. (Abstr. *Japan Med.*, 1: No. 2, 1960)

22160 STUDIES ON THE INFLUENCE OF X-RAY IRRADIATION IN VIT. B_2 METABOLISM. I. INFLUENCE OF VIT. B_2 DISTRIBUTION IN ORGANS OF RATS. K. Yokoyama, T. Kusumoto, and J. Nakamura (Wakayama Medical Coll., Japan). *Wakayama Igaku*, 10: 365-70 (1959).

X rays were directed to the liver region of albino rats. The distribution of vitamin B_2 in the liver, kidney, intestine, heart, spleen, and blood was investigated 6, 12, 18, and 24 hr after the irradiation. Total vitamin B_2 increased in these organs except in the blood; flavin mononucleotide (FMN) and free riboflavin (FR) increased without exception, and flavin adenine dinucleotide (FAD) decreased except in the spleen, that is, abnormal distribution of vitamin B_2 fractions was significant except in the spleen. Successive estimations of the fractions suggest that the metabolic disturbances by irradiation occur in the reaction $\text{FMN} \rightarrow \text{FAD}$ initially, then in $\text{FR} \rightarrow \text{FMN}$ and $\text{FR} \rightarrow \text{FAD}$. (Absts. *Japan. Med.*, 1: No. 7, 1960.)

22161 EFFECTS OF P^{32} IRRADIATION ON SKIN AND BLOOD VESSELS. H. Oga (Tottori Univ., Japan). *Yonago Igaku Zasshi*, 10: 850-65 (1959).

The early effects of P^{32} irradiation were studied in the blood vessels of the frog's tongue and later effects were observed in the ear lobe of the rabbit. There was spastic narrowing of the vessels, especially of small arteries, in the frog's tongue during irradiation. The effects on the human skin and combs of cocks were also studied. The change in skin color was recorded by the standard color of the Japanese Colour Institute. The greater the irradiated area, the greater the changes of skin color. The vessels were affected functionally in the early stage of irradiation and then showed narrowing and/or stenosis of the vessels 2 to 3 months following irradiation. (Abstr. *Japan Med.*, 1: No. 2, 1960)

Radiation Sickness

22162 (AD-249704) RELATIONSHIP OF DIETARY BALANCE OF MACRONUTRIENTS TO RESISTANCE TO LOW DOSES OF WHOLE-BODY RADIATION AS MEASURED BY CHANGES IN BRAIN FUNCTION. Progress Report No. 1, April 30, 1960–September 30, 1960. Paola S. Timiras (California. Univ., Berkeley). Apr. 30, 1960. Contract DA19-129-qm-1589. 7p.

The effects of a single dose of 500 r whole-body x irradiation on threshold and pattern of electroshock seizures and postictal depression were studied in male adult rats. A fall in the electroshock threshold was observed after irradiation up to the end of the testing period of 16 days. A delayed effect was noted on the pattern of maximal seizures and the duration of postictal depression: 18 days after irradiation, the rats present a shorter clonic phase, a shorter total seizure, and a longer period of depression before return of the righting reflex. (D.L.C.)

22163 (AF-SAM-61-58) RADIOPROTECTIVE AGENTS. ANALYSIS OF THE POTENTIAL ANTIRADIATION EFFECT OF NUCLEIC ACIDS OR THEIR PRECURSORS. Donald E. Rounds (Pasadena Foundation for Medical Research, Calif.). Dec. 16, 1960. 5p.

A total of nine compounds, including nucleic acids, purines, pyrimidines, and one nucleoside, were tested *in vitro* for activity as radioprotective agents. One agent which proved to be effective was yeast ribonucleic acid (RNA). Four others, which showed moderate potential, were calf thymus deoxyribonucleic acid (DNA), yeast DNA, orotic acid, and adenine. Guanine, xanthine, uracil, and deoxyadenosine had no protective effect in the test system. Yeast RNA was found to be relatively nontoxic to amnion cells over a 24-hr treatment period, but a chronic exposure of the cells to 0.5 mg/ml for 6 days caused a decrease in the growth rate to about 52% of control cultures. Preirradiation treatment of 7 different cell strains with 0.1 mg/ml yeast RNA resulted in a widely variable protective response. Treated populations of nonmalignant origin showed more cells surviving 700 r gamma radiation than did untreated, irradiated control cultures. Malignant cells, including KB, HeLa, and Detroit 6 strain of bone marrow, showed no protective response. (auth)

22164 (USNRDL-TR-511) THE GROWTH AND DIETARY PATTERN OF RATS ON SELF-SELECTION DIETS FOLLOWING WHOLE-BODY IRRADIATION. F. Konishi (Naval Radiological Defense Lab., San Francisco). May 22, 1961. 17p.

The apparent ability of rats to voluntarily select a dietary according to the needs of the body was utilized in a study to detect possible metabolic derangements subsequent to a dose of 375 rad whole-body x-irradiation. The animals were allowed free choice selections of various foodstuffs offered in separate containers and the relative amounts of food intake as well as body weights were measured daily. The majority of the rats were able to select diets adequate enough to support normal growth. Upon irradiation at the level employed, rats fed a basal pre-mixed diet lost significantly more body weight than similarly treated rats selecting their own diet. In the over-all pattern, the proportion of casein selected progressively increased whereas that of sucrose decreased subsequent to the irradiation. The selections of yeast and corn oil remained essentially the same. On the third day only, after irradiation, the intake of minerals increased to over 5 times the preirradiation level. The selection and intake of casein returned to pre-irradiation levels by the third day while the total caloric intake of

irradiated rats on basal and self-selected diets returned to normal levels by the 5th day. (auth)

22165 (JPRS-9456) EFFECT OF VITAMINS B₁ AND PP ON THE METABOLISM OF CITRIC AND FUMARIC ACIDS IN RADIATION SICKNESS. E. (Ye.) F. Sopin and V. M. Gayday. Translated from Ukrain. Biokhim. Zhur., 32: No. 1, 57-62(1961). 13p.

The influence of vitamins B-1 and PP on separate steps in the tricarboxylic acid cycle (metabolism of citric and fumaric acids) in radiation sickness was investigated. The administration of vitamins B-1 and PP to irradiated animals showed a certain stabilizing effect on the weight and increased their length of life. The administration of the vitamins also increased the renewal of citric and fumaric acids in the tissues of the irradiated animals. (M.C.G.)

22166 (JPRS-9457) EFFECT OF IRRADIATION ON THE PHYSICO-CHEMICAL PROPERTIES OF THE PROTEINS IN THE BLOOD SERUM. A. P. Maydanov, I. K. Pelikh, and I. P. Makarenko. Translated from Ukrain. Biokhim. Zhur., 32: No. 1, 88-93(1961). 8p.

Studies were made of the viscosity and electric conductivity of blood serum after irradiation with ultraviolet rays. In the horse serum used the outstanding component with respect to radiosensitivity was the proteins. The viscosity of the irradiated solutions increased by 0.25 to 0.5% with 15-min exposures and by 1 to 3% with 60-min exposures. The resistance of the irradiated solutions decreased, as compared to the non-irradiated solutions, to approximately the same extent as the viscosity increased. During irradiation, polymerization and denaturation of the proteins and partial photolysis occurred. (M.C.G.)

22167 CONTRIBUTIONS TO THE STUDY OF IMMEDIATE AND EARLY X-RAY REACTIONS WITH REGARD TO CHEMOPROTECTION. II. IRRADIATION AND CHEMOPROTECTION OF FRESH SYNOVIA AS A MODEL OF MYCOPOLYSACCHARIDE DEPOLYMERIZATION. R. Brinkman, H. B. Lamberts, and J. Zuideveld (Univ. of Groningen, The Netherlands). Intern. J. Radiation Biol., 3: 279-83(May 1961). (In English)

Fresh synovia is used as a natural solution of mucopolysaccharide macromolecules. Their immediate x-ray depolymerization is studied by measurement of relative viscosity. It is shown that in this case reducing radicals must be active, and strongly reducing substances are radiomimetic. (auth)

22168 THE EFFECT OF CYSTEAMINE ON THE RADIOSENSITIVITY OF THE HAEMOPOIETIC SYSTEM OF SEVERELY HYPOXIC MICE. L. Weiss (National Inst. for Medical Research, London). Intern. J. Radiation Biol., 3: 285-92(May 1961). (In English)

An attempt was made to determine whether the thiols alter the radiosensitivity of mammalian cells over and above that produced by the oxygen-effect. The mice were maintained in a state of profound hypoxia during irradiation by keeping them at body temperatures of 0 to 1°C. Damage was assessed five days after irradiation on total leucocyte counts and histological examination of the spleen and femoral bone marrow. On comparison with other experimental results, the difference between the protection given by the combination of severe hypoxia and cysteamine and by severe hypoxia alone, was of doubtful significance. It was concluded that cysteamine acts mainly through oxygen-dependent pathways. (auth)

22169 EFFECT OF VARIOUS CHEMICALS ON RADIATION SICKNESS. T. Eguchi (Keio Univ., Tokyo). Keio Igaku, 37: 127-39(1960).

Serum cholinesterase (ChE) activity was selected as an indicator of radiation sickness and its value was followed for 2 weeks after irradiation. ChE activity was markedly disturbed after a single exposure of 1000 r when the liver of rabbit was irradiated with doses ranging from 100 to 1000 r. The value of ChE activity after a dose of 1000 r was adopted as the standard and the deviation from this value was regarded as the effect of various chemicals. After administration of guroson or moriamin S prior to x irradiation, guroson did not show any protective effect, moriamin S was slightly effective. Thus the pre-irradiation administration of these drugs could not serve as protective agents. When guroson moriamin S, cobalt-greenpole, merthio B₁₂, panilint, diphenylpyraline, and cepharanthin were administered after x irradiation, 0.25 mg of cobalt-greenpole was most effective; the next in order are 200 mb guroson, 0.1 mg cepharanthin, 0.1 ml merthio B₁₂, and 2 mg diphenylpyraline, and 2 ml merthio B₁₂, 2 mg cepharanthin, 2 ml moriamin S, and 10 mg guroson. (Absts. Japan. Med., 1: No. 7, 1960.)

22170 STUDY ON THE CHEMICAL PROTECTION AGAINST RADIATION INJURIES. II. EFFECT OF VITAMINS B₂, B₆, H, C AND PANTOTHENIC ACID. T. Hashimoto (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1132-43(1959).

Pure-bred mice were irradiated with a single exposure of 800 r (lethal dose) and 680 r (LD₅₀) of x rays. No protective effect of vit. B₂, B₆, or pantothenic acid against radiation injury was recognized. Only vit. B₁ was effective. These 2 results indicate that the protective effect of vit. B₁ is due to activation of SH base. Neither pantothenic acid nor pantothein had any radiation-protective effect, but the combined use of pantothenic acid with β-mercaptoethylamine was effective. Probably the protection is due to some mechanism other than the SH group. Vit. H gave no protection, and there was some relationship between the dosage of vit. H and its toxicity. Vit. C gave some protection against radiation injury, believed to be due to cooperation with glutathione in the oxidation-reduction system. This mechanism seems to be different from that of other types of radiation-protective agents. (Abstr. Japan Med., 1: No. 8, 1961)

22171 EFFECT OF CYSTEINE AGAINST RADIATION-INDUCED KARYOKINETIC DECREASE AND CHROMOSOMAL ABERRATION. T. Machida (Showa Medical Coll., Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1243-50(1959).

Cysteine reduced the karyokinetic decrease induced by radiation in the root tip cells of beans. Chromosomal aberration caused by radiation was prevented by cysteine in Yoshida ascites tumors. Chromosomal bridges were reduced in number cysteine given before or immediately after irradiation. Chromosomal fragmentation was not influenced by cysteine treatment before or after irradiation. Bridge formation is caused, at least in part, by the indirect action of radiation, and fragment formation by the direct action. (Abstr. Japan Med., 1: No. 8, 1961)

22172 EXPERIMENTAL STUDY OF PROTECTIVE EFFECT OF 1-METHYL-2-MERCAPTOIMIDAZOLE ON RADIATION SICKNESS. I. A STUDY OF CHEMICAL PROTECTION AND RESTORATION AGAINST RADIATION INJURIES. Y. Koga (Kurume Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 19: 1469-91(1959).

The protective effect of 1-methyl-2-mercaptoimidazole (MI) on radiation sickness was investigated, using mice and rats. The effect of MI was compared with that of methyl-thiouracil (MT) under the same experimental con-

ditions. The administration of MI before irradiation caused marked prolongation of life span. Some favorable influence upon maintenance of the body weight also resulted. The administration of MI caused reduction and early recovery of leukopenia, particularly lymphopenia, following irradiation. In the pathological findings MI showed a marked protective effect against a loss of weight and the histological picture of the spleen. However, no definite effect was found on the changes of the liver and thyroid gland after irradiation. On the other hand the administration of MT caused no protective effect on radiation injuries. Both agents inhibited the thyroid function, with MT being more effective. (Absts. Japan. Med., 1: No. 7, 1960.)

22173 THE EFFECT OF PSEUDOMONAS PYROGEN ON SURVIVAL OF IRRADIATED MICE. E. J. Ainsworth and P. Donald Forbes (Argonne National Lab., Ill. and Brown Univ., Providence). *Radiation Research*, 14: 767-74 (June 1961).

Survival of x-irradiated mice is under certain conditions increased by treatment with *Pseudomonas pyrogen* 24 hours before or 24 hours after irradiation. The extent of protection, estimated in two strains of mice by treatment 24 hours before irradiation, was influenced by the dose of pyrogen, the route of injection, the number of injections, and the endogenous bacterial flora of the experimental animals. Intravenous administration of 0.4 μ g decreased mortality in BUB mice, but 0.8 μ g was the minimal effective dose in CF. No. 1/Anl mice. At a dosage of 2 μ g, intravenous injection decreased mortality by more than 75% in both strains of mice; however, at this dosage, both intraperitoneal and subcutaneous injections were ineffectual. Multiple subcutaneous injections given for 5 days before irradiation failed to reduce mortality. Endogenous bacterial flora exert the most profound effect on radiation protection with PP, for no protection was observed in experiments in which *Pseudomonas* was the principle organism associated with terminal bacteremia during the first postirradiation week. (auth)

22174 THE PROTECTIVE EFFECT OF CYSTEAMINE AGAINST GENETIC DAMAGES BY X-RAYS IN SPERMATOCYTES FROM MICE. K. G. Lüning, H. Frölen, and A. Nelson (Research Inst. of National Defense, Sundbyberg, Sweden). *Radiation Research*, 14: 813-18 (June 1961).

Males from the CBA strain of mice were given intraperitoneal injections with cysteamine or physiological saline, followed by 0 (control), 300, or 600 r of x rays. The males were each subsequently mated to 3 virgin CBA females for a period of 7 days. The females were killed on the sixteenth or the twentieth day after start of mating. The uteri were examined for live and dead embryos; 5145 embryos were analyzed. The rate of death was significantly lower among the offspring of males which were given cysteamine rather than saline prior to irradiation. The cysteamine reduced the rate of mutations to 75% of that in males given physiological saline only. (auth)

22175 CHEMICAL AND BIOLOGICAL PROTECTION AGAINST RADIATION DAMAGE. I. EFFECTS OF THE

ADMINISTRATION OF PROPERDINE IN ACUTE X RADIATION SICKNESS. Giuseppe Del Buono and Donato Fumarola (Università, Bari, Italy). *Radiobiol. radiotherap. e fis. med.*, [3] 16: 33-45 (1961). (In Italian)

The administration of purified human properdine (single dose 25 units/kg body weight injected intravenously) two hours before massive whole-body x-irradiation (2000 r) causes in rabbits a survival, for 50% of the animals treated, beyond the 192nd hour after irradiation. Control rabbits, inversely, die within the third hour. Moreover, while in the experimental animals the properdine level is maintained within normal limits, in the controls there is a sharp and distinct drop of this defensive index. (tr-auth)

22176 STUDIES ON PROTECTIVE AGENT AGAINST RADIATION HAZARD. II. PROTECTIVE AGENTS AGAINST γ -RAYS. [PART] I. M. Namiki (Inst. of Physical and Chemical Research, Tokyo). *Rikagaku Kenkyusho Hokoku*, 35: No. 2, 176-81 (1959).

The survival rates of mice after γ irradiation were studied. It was found that a dose of 1000 r was LD₁₀₀ after 10 days of observation, and the biological effect of γ rays was about 70% that of x rays. Cysteamine HCl, glutathione, inositol, isoleucine, agmatine, tryptamine, δ -mercapto-n-valerylhydrazide, ascorbic acid, cysteine, and thiouracil were tested for their protective action against radiation hazard. Glutathione was initially effective then suddenly decreased in its effectiveness and showed no change when compared with that of the control group. Tryptamine was the most effective substance. isoLeucine, agmatine, and vitamin C were fairly effective. (Abstr. Japan Med., 1: No. 2, 1960)

22177 RADIOPROTECTIVE ACTIVITY OF A PHENANTHRENE DERIVATIVE IN MICE. Wendell H. Rooks, II and Ralph I. Dorfman (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). *Science*, 134: 111 (July 14, 1961).

22178 EFFECTS OF PERISTON ON THE COURSE OF THE ACUTE RADIATION SYNDROME. Klaus Damminger and Emil H. Graul (Universität, Marburg/Lahn, Ger.). *Strahlentherapie*, 115: 203-11 (June 1961). (In German)

The action of Periston on the course of the acute radiation syndrome was examined in an animal experiment. A protection effect with the intraperitoneal application after the radiation is demonstrated. The most favorable action could be attained in LD_{50/30d}. The contradictory results of the earlier workers were produced: the positive ones by radiating in the morning, the negative ones by radiating in the afternoon. Herewith a decisive role to the "initial situation" was attributed in the pathogenesis and the protective effect. On grounds of detailed examinations of leucocytes and thrombocytes in the peripheral blood the work hypothesis was brought about, that the radiotoxins arising after "monophasic"-whole body radiation in the course of the radiation syndrome, radiation induced "x-substances" were reduced by Periston. (auth)

CHEMISTRY

General and Miscellaneous

22179 (AERE-M-800) THE REDUCTION OF URANIUM OXIDES WITH MOLTEN ZINC-MAGNESIUM ALLOYS. G. F. Hewitt (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1961. 21p.

The reaction between uranium oxides and zinc-magnesium alloys was studied at 800°C; the effects of composition of reducing alloy and stirring rate were investigated. Reaction with stoichiometric alloy was extremely slow but as the concentration of magnesium was increased the rate of reaction passed through a maximum. Earlier experiments using qualitative and quantitative micrographic analytical techniques, and supporting solubility and density measurements in the Zn-Mg-U system, are described. (auth)

22180 (AERE-R-3682) THE THERMODYNAMIC PROPERTIES OF DILUTE SOLUTIONS OF UCl_3 IN LiCl-KCl EUTECTIC. B. A. Partridge (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1961. 25p.

The emf measurements made by other workers on galvanic cells of the form $\text{U}|\text{UCl}_3$ in LiCl-KCl eutectic $|| \text{AgCl}$ in LiCl-KCl eutectic $|\text{Ag}$ at 440 to 550°C were used to derive the thermodynamic properties of UCl_3 in LiCl-KCl eutectic for concentrations of UCl_3 up to 3.5 wt.%. It is concluded that UCl_3 exhibits marked positive deviations from Raoult's Law in LiCl-KCl eutectic; the activity coefficient at infinite dilution at 500°C being approximately 6.3. (auth)

22181 (AFOSR-724) RARE EARTH OXIDE SYSTEMS. PART II. THE INFRARED SPECTRA OF PRASEODYMIUM OXIDE AND PRASEODYMIUM CARBONATE. Paul A. Faeth and Alan F. Clifford (Purdue Univ., Lafayette, Ind.). Apr. 17, 1961. Contract AF18(603)-45. 17p.

Several samples of PrO_x were prepared which have x values between 1.50 < x < 1.83; by decomposing $\text{PrO}_{1.83}$ in vacuo any x value could be prepared. The preparations were analyzed for infrared absorption activity in the region of 2 to 16 microns. An absorption band at about 15 microns appeared for all samples if the specimens were permitted access to the atmosphere. No band appeared in this region if the samples were analyzed immediately after their preparation. Infrared analysis of samples of praseodymium carbonate and praseodymium hydroxide showed absorption activity in the same regions where activity was noted for air-exposed praseodymium oxide samples. It was concluded that the absorption band at 15 microns for the air-exposed oxides is due to hydration-carbonation effects. The band is probably indicative of a metal-oxygen bond as proposed by Meloeche for oxide systems; the band might also be due to a (chemi) sorbed species (CO_2 or H_2O). A sample of praseodymium carbonate was decomposed in vacuo and the spectrum of the resultant compound was observed. A differential thermal analysis of the carbonate in air showed that the dehydration probably is complete below 300°C; the carbonate loses CO_2 at 470°C and 630°C and is subsequently converted to the oxide Pr_2O_{11} near 400°C. (auth)

22182 (DP-571) IDENTIFICATION OF HYDROCARBON TYPES IN "ULTRASENE." Richard N. Wilhite (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1961. Contract AT(07-2)-1. 12p.

The C^{11} - C^{14} components of a sample of "Ultrasene" were identified as normal- and iso-paraffins; mono-, bi-, and tri-cycloparaffins; alkylbenzenes; indans; indenenes; naphthalenes; and acenaphthenes. The aromatic content of this sample was 3.0 vol %. (auth)

22183 (FRL-TR-36) DILUTE SOLUTION PROPERTIES OF AN UNFRACTIONATED POLY(N-DOCOSYL METHACRYLATE). Eleanor C. Schramm, Richard J. Valles, and David W. Levi (Picatinny Arsenal. Feltman Research Labs., Dover, N. J.). May 1961. 69p. (PB-155877)

Initial light scattering measurements on unfractionated poly(n-docosyl methacrylate) indicated a molecular weight somewhat higher than 8×10^6 , which suggests some kind of association. Subsequent studies in three solvents at different temperatures showed no evidence of any association. Determinations were made of molecular weights, chain dimensions, and second virial coefficients at a series of temperatures in two solvents. (D.L.C.)

22184 (HW-SA-2210) THE AFFINITY OF HYDROHALIC ACIDS FOR TRI-N-OCTYLAMINE. Archie S. Wilson and Ned A. Wogman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 1961. Contract AT(45-1)-1350. 12p.

Affinity constants of HF, HCl, HBr, and HI for tri-n-octylamine were measured in four different organic solvents. The acid number, or the ratio of moles of acid extracted into the organic phase to moles of amine, was also measured. Observations on the formation of two or more organic phases are reported. The results are discussed in terms of the ion-pair theory. (D.L.C.)

22185 (NAA-SR-6131) LAW OF CORRESPONDING STATES FOR FUSED SALTS. H. Reiss, S. W. Mayer, and J. Katz (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 31, 1961. Contract AT(11-1)-GEN-8. 21p.

Reduced equations of state were developed for strictly ionic salts through an analysis of the configuration integral. In this way appropriate laws of corresponding states were developed for vapor pressures, surface tensions, and melting points. Agreement between theory and experiment was satisfactory for a large class of salts. (auth)

22186 (NAA-SR-6384) THE THERMODYNAMIC PROPERTIES OF URANYL SULFATE. B. B. Owens and S. W. Mayer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 30, 1961. Contract AT(11-1)-GEN-8. 13p.

Equilibrium vapor pressures of water for the systems $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ — $\text{UO}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ and $\text{UO}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ — UO_2SO_4 were measured in the range from 280 to 400°K. The heat capacities of UO_2SO_4 , $\text{UO}_2\text{SO}_4 \cdot \text{H}_2\text{O}$, and $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ were determined by drop calorimetry. These vapor pressure and heat capacity data were used to calculate the free energy and enthalpy for the dehydration of $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ and $\text{UO}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ and for the formation of UO_2SO_4 and $\text{UO}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ from 298 to 820°K. The entropy of UO_2SO_4 was found to be 40 ± 6 e. u. at 298°K, which agrees with the entropy estimate made by Latimer's method. (auth)

22187 (NAA-SR-Memo-6107) RUTHENIUM REMOVAL FROM IRRADIATED UO_2 BY REACTION WITH OXYGEN TO 1300°C. L. J. Colby, Jr. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 7, 1961. 12p.

The removal of ruthenium from UO_2 irradiated at 1×10^{18} nvt by reaction with oxygen to 1300°C was investigated as a possible step in chemical reprocessing of spent nuclear fuel. Below 600°C, no ruthenium removal was noted; at 700°C, half of the original ruthenium volatilized; at 1300°C, a decontamination factor of 25 was obtained. 96% of the original ruthenium was removed. Data at 700°C indicate that all the ruthenium which is eventually removed is removed within 60 minutes. The removal of ruthenium at 600°C by alternate oxidation-reduction cycles on UO_2 occurs to a lesser extent than previously suggested. After five oxidation cycles a decontamination factor of 2.4 was obtained. (auth)

22188 (NBS-MON-20) IDEAL GAS THERMODYNAMIC FUNCTIONS AND ISOTOPE EXCHANGE FUNCTIONS FOR THE DIATOMIC HYDRIDES, DEUTERIDES, AND TRITIDES. Lester Haar, Abraham S. Friedman, and Charles W. Beckett (National Bureau of Standards, Washington, D. C.). Monograph 20. May 29, 1961. 271p.

This monograph contains a consistent set of tables of thermodynamic properties of a number of diatomic hydrides, deuterides, and tritides, for the ideal gas state at one atmosphere pressure. In addition to the thermodynamic properties of the molecular gases, the tables include thermodynamic properties for chemical reactions involving the isotopic exchange of hydrogen. The thermodynamic properties tabulated are the heat capacity, enthalpy, Gibbs free energy, and entropy. (auth)

22189 (SRB-61-2(Vol.II)) PROPERTIES OF CADMIUM SULFIDE, ZINC SULFIDE AND MERCURIC SULFIDE. PART 4. An Annotated Bibliography. Helen M. Abbott, Comp. (Lockheed Aircraft Corp., Sunnyvale, Calif.). Mar. 1961. 101p.

An annotated bibliography is presented containing selected references on the electro-optical properties of CdS, ZnS, and HgS. The references were obtained from a search of: Science Abstracts (1950 to 1961), Nuclear Science Abstracts (1951 to 1961), the Armed Services Technical Information Agency, and various periodicals translated from the Russian language. (241 references) (M.C.G.)

22190 (TID-12991) CHEMISTRY OF POLYVALENT METAL HALIDES. Technical Progress Report, March 1, 1960 to February 28, 1961. Herbert C. Brown (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-170. 251p.

In order to determine the effect of bulky groups on the diborane structure, the hydroboration reaction of highly substituted olefins was studied. The hydroboration of 2-methyl-2-butene yielded bis-3-methyl-2-butylborane in 99% yield. Molecular weight determinations and infrared spectra identified the compound as a dimer having unusual physical properties. The dimer reacted with diborane to form the unsymmetrical dimer, 1,1-(3-methyl-2-butyl)diborane. Other borane dimers reacted in a similar manner. The hydroboration of cyclohexene and 1-methylcyclohexene in stoichiometric ratios yielded the tetra-alkyl-diboranes in quantitative yields. The reactions of the terminal olefins with diborane in THF yielded mixtures of R_2BH and R_4B only when the olefin was added to the THF: BH_3 solutions. The system gallium chloride in toluene, was investigated at 0°C, and a complex having the composition $\text{C}_6\text{H}_5\text{CH}_2\text{:Ga}_2\text{Cl}_6$ which was completely miscible with toluene was found. A comparison was made of the ability of hydro-

gen chloride to dissolve in pure toluene and in a solution of gallium chloride in toluene between the temperatures of -78.5 and 0°C. The rate of chlorine exchange, using Cl^{36} , between gallium chloride and methyl chloride was measured at -36°C. The rate of methylation of toluene was found to be a function of toluene concentration. The rate and isomer distribution in the gallium bromide catalyzed ethylation of the halobenzenes in ethylene dichloride solution was investigated. The relative rate and isomer distributions in the bromination of alkylbenzenes in 85% acetic acid were determined. Experiments are in progress to measure the heats of reaction of boron Lewis acids with various Lewis bases. The borohydride reduction of some phenyl substituted ketones is also being investigated. (M.C.G.)

22191 (TID-13056) THE COMPLEXES OF SOME 5-SUBSTITUTED TETRAZOLES WITH NICKEL (II). Ned A. Daugherty and C. H. Brubaker, Jr. (Michigan State Univ., East Lansing. Kedzie Chemical Lab.). [1961]. Contract AT(11-1)-399. 12p.

Unlike copper, nickel (II) forms only impure and poorly characterized compounds when its salts react with various 5-substituted tetrazoles in water, alcohols, dimethylformamide, and other solvents. However in solutions, particularly in dimethylformamide, complexation is clearly indicated by studies of absorption spectra. In some cases, such as 5-aminotetrazole, 2:1 complexes are formed, but with others, such as 5-phenyltetrazole, only $[\text{C}_7\text{H}_5\text{N}_4]/[\text{Ni}^{++}] = 3/2$ is indicated. Nickel spectra suggest only octahedral coordination. (auth)

22192 (TID-13059) THE CHEMISTRY OF BORON IN PLANTS. Technical Progress Report for Period Ending June 1, 1961. S. Aronoff (Iowa State Univ., Iowa City). Contract AT(11-1)-59. 7p.

Studies were made of the reaction: $\text{B}^{10} + \alpha n \rightarrow \text{B}^{11*} + \gamma$ to ascertain the feasibility of autoradiographic determination of classes of B compounds in plants following paper chromatography. The low concentration of B in plant tissues and the intrinsic amount of γ -rays accompanying the thermalized neutrons appear to invalidate this procedure. Improved procedures for the growing of B-deficient plants were devised. Studies were made of the rate of formation of amino acids in B-deficient and normal plants. Although (as shown previously) the rate of photosynthesis of deficient plants is equivalent qualitatively to the normal plants, we have now shown that for equivalent amounts of surface area the amount of C^{14}O_2 in amino acids in leaves is higher in the B-deficient plants. Kinetic analysis shows that this margin is increased (though slowly) with time. (auth)

22193 (WADD-TR-61-255) SYNTHESIS AND EVALUATION OF THERMALLY STABLE POLYMERS. PART I. POLYMER SYNTHESIS. G. P. Brown and A. Goldman. PART II. POLYMER EVALUATION. D. C. Doyle (General Electric Co. General Engineering Lab., Schenectady, N. Y.). May 1961. Contract AF33(616)-7076. 99p.

Poly-m-phenoxylyene was synthesized with number average molecular weights approaching 4,000 and, in one case, a weight average molecular weight of 6,800. The synthesis routes studied included self-condensation of alkali metal salts of m-bromophenol, condensation of salts of resorcinol with m-dibromobenzene, and self-condensation of resorcinol. In addition to polymer, four syntheses provided small amounts of crystalline material indicated as being cyclic oligomers, presumably trimer and tetramer. Study of a variety of reaction conditions indicates that anhydrous conditions are essential to minimize carbon-carbon coupling; and that purity of the starting material m-bromophenol is probably the most important cause for failure, as

yet, to achieve higher molecular weights, but that low rates of reaction under heterogeneous conditions may adversely affect molecular weights by promoting cyclization reactions. A single sample of poly-*m*-phenoxyene, having low functional group content, was tested via thermogravimetric analysis and was shown to possess outstanding thermal stability, 3% weight loss up to 500°C. The results of concluding thermal stability studies and preliminary heat-softening studies are presented. Topics treated include: methods of kinetic analysis of thermogravimetric data, illustrated for zero-order (octamethylcyclotetrasiloxane) and first-order (polytetrafluoroethylene) volatilization; effects of varying sample geometry in thermogravimetry; thermoparticulate analysis as a means of observing incipient and vestigial volatilization; differential thermal analysis, volume dilatometry, x-ray and electron diffractometry, methods of observing mechanical, electrical and nuclear magnetic relaxation effects, and a new heat-softening test. As a part of the study of nuclear magnetic resonance, some styrene-divinylbenzene copolymers of various degrees of cross-linking are compared. (auth)

22194 (AEC-tr-4061) JOURNAL OF INORGANIC CHEMISTRY. Translation of Zhurnal Neorganicheskoi Khimii, Volume II, No. 11, 1957. 331p. (PST-Cat.-88)

Twenty-five papers are included which treat various topics in inorganic chemistry. Separate abstracts were prepared for five of the papers. (D.L.C.)

22195 (AEC-tr-4061(p.267-75)) STUDY OF THE TERNARY SYSTEM SODIUM CHLORIDE-CESIUM CHLORIDE-WATER. V. E. Plyushchev, V. B. Tulinova, G. P. Kuznetsova, S. S. Korovin, and N. S. Shipetina. Translated from Zhur. Neorg. Khim., 2: 2654-60 (1957).

Solubility isotherms for the system NaCl-CsCl in H₂O were determined at 25, 50, and 75°C. The isotherms were found to consist of two branches corresponding to the crystallization of pure NaCl and of a phase which supposedly consists of a solid solution on a CsCl base. Studies of the solid solution and determinations of density-composition isotherms for saturated solutions were made which confirm the character of the solubility isotherms. (D.L.C.)

22196 (AEC-tr-4061(p.307-9)) THE PREPARATION OF A RADIOCHEMICALLY PURE RADIOACTIVE GERMANIUM. A. N. Baraboshkin. Translated from Zhur. Neorg. Khim., 2: 2680-1 (1957).

Two methods of purifying Ge⁷¹ were tested: (1) precipitation of GeS₂ from H₂SO₄ solution and dissolution on the filter, and (2) distillation of GeCl₄ from HCl solution. Both methods were found to result in pure Ge⁷¹ samples which follow the law of absorption of monochromatic x rays. (D.L.C.)

22197 (AEC-tr-4474) TRANSACTIONS OF THE V. G. KHLOPIN RADIUM INSTITUTE. VOLUME VIII. CHEMISTRY AND GEOCHEMISTRY. I. E. Starik, ed. Translation of Trudy Radiyevogo Instituta imeni V. G. Khlopina, Volume VIII. A publication of the Publishing House of the Academy of Sciences U.S.S.R. Press, Moscow-Leningrad, 1958. 332p.

Thirty papers are included which treat the following subjects: behavior of uranyl nitrate in ethyl ether and water, peroxyuranates, electrolytic separation of polonium, uranium-thorium separation, uranium contents of natural waters, etc. Separate abstracts have been prepared for each of the papers. (D.L.C.)

22198 (AEC-tr-4474(p.1-7)) THE DISTRIBUTION OF DIFFERENT NITRATES BETWEEN AQUEOUS SOLUTIONS AND DIETHYL ETHER. B. A. Nikitin, V. M. Vdovenko,

and M. A. Golutvina. Translated from Trudy Radiyevogo Inst. im. V. G. Khlopina, 8: 3-7 (1958).

The distribution coefficients of nitrates of different groups of the periodic table between aqueous solutions and diethyl ether were measured. Al(NO₃)₃ and NH₄NO₃ were used as salting-out agents. Most nitrates were found to have coefficients less than 0.0001. Relationships are derived between the distribution coefficients of alkali metal and alkaline earth metal nitrates and the ionization potentials of the metals. (D.L.C.)

22199 (AEC-tr-4474(p.8-19)) DETERMINATION OF THE SOLUBILITY OF URANYL NITRATE IN DIETHYL ETHER. V. M. Vdovenko, M. P. Koval'skaya, and M. M. Gerbanevskaya. Translated from Trudy Radiyevogo Inst. im. V. G. Khlopina, 8: 8-16 (1958).

A solution of UO₂(NO₃)₂ · 2H₂O in anhydrous (C₂H₅)₂O was prepared and subjected to dehydrating agents. The solid separating from the solution at 15°C was analyzed and found to correspond to UO₂(NO₃)₂ · 2H₂O · 2(C₂H₅)₂O. The solubility of UO₂(NO₃)₂ in (C₂H₅)₂O was measured at -60 to +20°C; a new phase was found to separate at 0 to -60°C and to have the composition UO₂(NO₃)₂ · 2H₂O · 4(C₂H₅)₂O. The melting points of the complexes containing 2 and 4 molecules (C₂H₅)₂O were determined to be +47 ± 0.5 and +2 ± 0.5°C, respectively. The dissociation pressures of the two complexes were measured at various temperatures; the results give 12.5 kcal/mole heat evolved in the addition of 2(C₂H₅)₂O to UO₂(NO₃)₂ · 2H₂O and 10.9 kcal/mole heat evolved in further addition of 2(C₂H₅)₂O to give the complex UO₂(NO₃)₂ · 2H₂O · 4(C₂H₅)₂O. (D.L.C.)

22200 (AEC-tr-4474(p.20-6)) DETERMINATION OF THE SOLUBILITY OF URANYL NITRATE IN DIETHYL ETHER. V. M. Vdovenko, T. V. Kovaleva, and E. A. Moskal'kova. Translated from Trudy Radiyevogo Inst. im. V. G. Khlopina, 8: 17-21 (1958).

The solubility of UO₂(NO₃)₂ · 6H₂O in (C₂H₅)₂O was determined at +25 to -10°C, and the solid phase in equilibrium with the solutions at 0 to 25°C was found to be UO₂(NO₃)₂ · 3H₂O · (C₂H₅)₂O with a melting point of 62 ± 0.5°C. The dissociation pressure of UO₂(NO₃)₂ · 3H₂O · (C₂H₅)₂O was measured and used to derive the heat of addition of 1 mole (C₂H₅)₂O to UO₂(NO₃)₂ · 3H₂O, 8.1 kcal. It was found that if (C₂H₅)₂O is used to dissolve the di-, tri-, and hexa-hydrate of UO₂(NO₃)₂ in amounts equal to 1 wt.% on the basis of the anhydrous salt and the solution evaporated, UO₂(NO₃)₂ · 2H₂O · 2(C₂H₅)₂O precipitates. (D.L.C.)

22201 (AEC-tr-4474(p.27-30)) DETERMINATION OF THE SOLUBILITY OF URANYL NITRATE IN DIETHYL ETHER. V. M. Vdovenko and T. V. Kovaleva. Translated from Trudy Radiyevogo Inst. im. V. G. Khlopina, 8: 22-4 (1958).

Pure anhydrous UO₂(NO₃)₂ was prepared and its solubility in anhydrous (C₂H₅)₂O determined at 0, 15, and 25°C. The solid phase in equilibrium with the solutions was found to consist of UO₂(NO₃)₂ · 2(C₂H₅)₂O. The solubility is low compared with that of the hydrates of UO₂(NO₃)₂. (D.L.C.)

22202 (AEC-tr-4474(p.31-5)) DETERMINATION OF THE HEAT OF SOLUTION OF CRYSTALLINE HYDRATES OF URANYL NITRATE IN WATER AND IN DIETHYL ETHER. V. M. Vdovenko and L. A. Mal'tseva. Translated from Trudy Radiyevogo Inst. im. V. G. Khlopina, 8: 25-9 (1958).

The heats of solution of hexa-, tri-, and di-hydrates and of anhydrous uranyl nitrate were determined to be, respectively, -1.25, +7.07, +9.52, and +18.36 kcal/mole for ethyl ether and -5.51, +1.69, +4.94, and +11.90 kcal/mole for

water. The heats of solution are more positive for ether as compared with water, the difference being in the range of 4.3 to 6.5 kcal/mole. Some observations on the implications of the data are made. (D.L.C.)

22203 (AEC-tr-4474(p.36-45)) ON THE CORRELATION BETWEEN THE AMOUNTS OF URANYL NITRATE AND WATER IN ETHER SOLUTIONS SATURATED WITH WATER. V. M. Vdovenko and V. I. Zemlyanukhin. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 30-7(1958).

A study was made of the amounts of water required to saturate ether solutions of uranyl nitrate. The correlations between the amounts of uranyl nitrate and water indicate that uranyl nitrate in ether solutions exists in the form of a tetrahydrate. A ternary phase diagram is drawn from the experimental data for the ethyl ether-uranyl nitrate-water system. (D.L.C.)

22204 (AEC-tr-4474(p.46-55)) ELECTRIC CONDUCTIVITY OF ETHER SOLUTIONS OF URANYL NITRATE. V. M. Vdovenko, T. V. Kovaleva, and I. G. Veriginia. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 38-46(1958).

The electric conductivities of ether solutions of uranyl nitrate hydrates were measured as a function of concentration and temperature. The ether solutions exhibit considerable conductivity; for example, a 40% $\text{UO}_2(\text{NO}_3)_2$ solution of the hexahydrate has a specific conductance which is 10^5 of that of ether saturated with water and $1/_{100}$ of that of an aqueous solution of the same concentration. The conductivity increases with the amount of water of crystallization in the hydrate. The molecular conductivity of ether solutions of the hexahydrate and trihydrate has a maximum in the region of a concentration corresponding to 35% $\text{UO}_2(\text{NO}_3)_2$, while solutions of the dihydrate exhibit no maximum. The data are interpreted in terms of conducting complexes. (D.L.C.)

22205 (AEC-tr-4474(p.56-62)) STUDY OF THE DISTRIBUTION OF URANYL NITRATE BETWEEN AQUEOUS SOLUTIONS AND DIETHYL ETHER. V. M. Vdovenko and T. V. Kovaleva. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 47-52(1958).

The distribution of $\text{UO}_2(\text{NO}_3)_2$ between aqueous solutions and ethyl ether was measured as a function of $\text{UO}_2(\text{NO}_3)_2$ concentration in the aqueous phase and of temperature. The results show a decrease of the distribution coefficient with decreasing aqueous concentration and increasing temperature. Addition of $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ to dry ether beyond 12.6% on the basis of anhydrous salt was found to result in formation of an aqueous phase. (D.L.C.)

22206 (AEC-tr-4474(p.63-8)) ELECTROLYTIC METHOD OF URANIUM SEPARATION FROM ALKALINE SOLUTIONS OF PERURANATES. A. M. Gurevich and M. L. Kovalevskaya-Yashchenko. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 53-7(1958).

A method is outlined for separating U from alkaline solutions of peruranates. In this method, U is dissolved in excess alkali and H_2O_2 , and separation of U from this solution is effected by electrolysis at 80 to 100°C. Variations of this method are presented for separating U from Fe, Al, H_3PO_4 , and V. Acetates, oxalates, sulfates, and fluorides do not interfere, while oxidizing agents prevent the electrolytic deposition of U. (D.L.C.)

22207 (AEC-tr-4474(p.69-91)) STUDY OF THE MECHANISM OF ELECTROLYTIC SEPARATION OF URANIUM FROM ALKALINE SOLUTIONS OF PERURANATES. A. M. Gurevich, L. D. Preobrazhenskaya, and N. P.

Osicheva. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 58-76(1958).

The kinetics of thermal decomposition of peroxide in dilute Na_4UO_8 solutions at high temperatures in the absence and presence of electrolytic current were studied. The decomposition process was found to take place in two stages: (1) decomposition of two particles of added peroxide at the same rate as free peroxide and (2) decomposition of combined peroxide. Pt and direct current were found to have a catalytic effect on the decomposition of combined peroxide. The compositions of the decomposition product of Na_4UO_8 and of the compound separating at the cathode during electrolysis of Na_4UO_8 solutions were studied. The electrolytic deposit was found to consist of sodium urano-uranate with the probable formula $\text{Na}_3\text{H}_3\text{U}_7\text{O}_{20} \cdot 16\text{H}_2\text{O}$. The effects of oxidizing agents on electrolytic separation of U were studied; K_2CrO_4 interferes with U separation from solutions whose U concentration is below the limit of uranate formation. (D.L.C.)

22208 (AEC-tr-4474(p.92-103)) SOLUBILITY OF THE SALT $\text{Na}_4\text{UO}_8 \cdot 9\text{H}_2\text{O}$ IN WATER AND IN SOLUTIONS OF VARIOUS ELECTROLYTES. A. P. Ratner, A. M. Gurevich, and L. P. Polozhenskaya. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 77-85(1958).

$\text{Na}_4\text{UO}_8 \cdot 9\text{H}_2\text{O}$ was prepared and a roentgenographic study of its structure made. Its solubility in H_2O and in solutions of NaOH, HNO_3 , and sodium salts was determined at 25°C, and the temperature dependence of the solubility measured for H_2O and solutions of NaOH and HNO_3 . NaOH, NaNO_3 , $\text{NaC}_2\text{H}_3\text{O}_2$, and Na_2CO_3 were found to decrease the solubility, while HNO_3 and NaHCO_3 increased the solubility due to the reactions $\text{Na}_4\text{UO}_8 + 2\text{HNO}_3 \rightarrow \text{Na}_2\text{UO}_6 + 2\text{NaNO}_3 + \text{H}_2\text{O}_2$ and $\text{Na}_4\text{UO}_8 + 2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{UO}_6 + 2\text{Na}_2\text{CO}_3 + \text{H}_2\text{O}_2$. Increases of solubility at high temperatures are due to formation of readily soluble peruranate complexes. (D.L.C.)

22209 (AEC-tr-4474(p.104-18)) STUDY OF THE PRODUCTS OF HYDROLYSIS AND THERMAL DECOMPOSITION OF THE SALT $\text{Na}_4\text{UO}_8 \cdot 9\text{H}_2\text{O}$ IN AQUEOUS AND ALKALINE SOLUTIONS. A. M. Gurevich and L. P. Polozhenskaya. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 86-98(1958).

The products of hydrolysis of Na_4UO_8 solutions of different pH at room temperature and of thermal decomposition of alkaline Na_4UO_8 solutions at 80 to 100°C were analyzed. Several peruranates were formed, two of which correspond to the formulas $\text{Na}_4\text{HU}_4\text{O}_{22} \cdot 21\text{H}_2\text{O}$ and $2\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 3\text{O} \cdot 2\text{H}_2\text{O}$. The solubility of $2\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 3\text{O} \cdot 2\text{H}_2\text{O}$ in water and NaOH solutions was determined at 100°C, and recipes are given for its preparation from Na_4UO_8 and $\text{UO}_2(\text{NO}_3)_2$. It is shown that precipitation from Na_4UO_8 solutions is due to hydrolysis of a peruranate in which the Na/U and O/U ratios are nearly unity. (D.L.C.)

22210 (AEC-tr-4474(p.119-32)) STUDY OF THE PROCESSES OF THERMAL DECOMPOSITION AND HYDROLYSIS OF THE SALT $\text{Na}_4\text{UO}_8 \cdot 9\text{H}_2\text{O}$ IN ALKALINE AND IN AQUEOUS SOLUTIONS AT A TEMPERATURE OF 80 to 99°. A. P. Ratner, A. M. Gurevich, L. D. Preobrazhenskaya, and N. P. Osicheva. Translated from Trudy Radiovego Inst. im. V. G. Khlopina, 8: 99-109(1958).

A study of the thermal decomposition and hydrolysis of Na_4UO_8 solutions at 80 to 99°C was made using peroxide decomposition curves and colorimetry. The decomposition process was found to be different in aqueous and alkaline solutions. In aqueous solutions, a complex, $\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 2\text{O}$, is formed which has an absorption coefficient of ~ 82 . In alkaline solutions, peroxide decomposition occurs in two stages. In the first stage, complexes are formed with O/U

ratios in the range 2.0 to 1.0 and an absorption coefficient of ~ 257 . In the second stage (decomposition of combined peroxide), these complexes decompose to form less strongly colored complexes with O/U ratios less than 1.0. The results indicate the stablest compound to be $\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 2\text{O}$. (D.L.C.)

22211 (AEC-tr-4474(p.133-41)) STUDY OF THE PROCESS OF HYDROLYSIS OF THE SALT Na_4UO_8 . A. P. Ratner, A. M. Gurevich, L. D. Preobrazhenskaya, and N. F. Simonov. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 110-16(1958).

A colorimetric and potentiometric study was made of the hydrolysis of aqueous Na_4UO_8 solutions at room temperature. The hydrolysis of Na_4UO_8 was found to depend on U concentration. In the U concentration range of 5×10^{-4} to 1.5×10^{-3} M, hydrolysis occurs in two stages, with the second stage occurring upon acidification. In more concentrated solutions, both hydrolysis steps merge into a single process, and the degree of hydrolysis drops. Addition of 3 equivalents HNO_3 per 1 g-atom U to Na_4UO_8 solutions results in the formation of a $\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 2\text{O}$ complex. (D.L.C.)

22212 (AEC-tr-4474(p.142-6)) ROENTGENOMETRIC STUDY OF SOME PRECIPITATES SEPARATED FROM ALKALINE SOLUTIONS OF SODIUM PERURANATES. V. V. Kurbatov. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 117-21(1958).

X-ray powder diffraction studies were made on three orange and three green-black precipitates obtained from alkaline solutions of sodium peruranates. The orange uranates were found to have crystalline structure, while the green-black uranates (urano-uranates) were amorphous. Some of the derived formulas for the uranates are $\text{Na}_3\text{U}_7\text{O}_{28} \cdot 7\text{H}_2\text{O}$ and $\text{Na}_9\text{HU}_7\text{O}_{28} \cdot 14\text{H}_2\text{O}$. (D.L.C.)

22213 (AEC-tr-4474(p.147-52)) ROENTGENOMETRIC STUDY OF SODIUM PERURANATES. V. V. Kurbatov. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 122-6(1958).

The results are presented for x-ray powder diffraction studies of $\text{Na}_4\text{UO}_8 \cdot 9\text{H}_2\text{O}$, $\text{UO}_4 \cdot 4.5\text{H}_2\text{O}$, and various peruranates such as $\text{Na}_7\text{HU}_4\text{O}_{22} \cdot 21\text{H}_2\text{O}$ and $2\text{Na}_2\text{O} \cdot 2\text{UO}_3 \cdot 3\text{O} \cdot 2\text{H}_2\text{O}$. Uranates containing small amounts of peruranates are included. (D.L.C.)

22214 (AEC-tr-4474(p.153-65)) DETERMINATION OF ELECTRODE POTENTIALS OF RADIOACTIVE ELEMENTS. D. M. Ziv and G. S. Sinitsyna. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 127-37(1958).

A method for determining the electrode potentials of radioelements is proposed which is more accurate (± 0.002 v) than the external electrolysis method of Hevesy and Paneth. In this so-called internal electrolysis method, a short-circuited cell is used with a redox system containing an Au plate in a solution of the radioelement and a Pt electrode immersed in a medium. The electrode potential $\text{Po}_{\text{metal}}/\text{Po}_{\text{ion}}$ on Au in 0.01 N HCl was determined with this method for a Po concentration of 10^{-10} M and found to be $+0.617 \pm 0.002$ v. (D.L.C.)

22215 (AEC-tr-4474(p.166-9)) DETERMINATION OF THE POTENTIAL OF SEPARATION OF POLONIUM ON PLATINUM. D. M. Ziv and G. S. Sinitsyna. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 138-40(1958).

The electrolytic separation of Po from solution on Pt electrodes was found to be of regular electrochemical nature. The electrode potential of Po on Pt in 0.1 N HCl at a Po concentration of 10^{-10} M was measured to be $+1.327 \pm$

0.003 v. Evidence for combination of deposited Po with Pt surfaces is presented. (D.L.C.)

22216 (AEC-tr-4474(p.170-83)) DETERMINATION OF POLONIUM IN SOLUTIONS. B. P. Nikol'skii (Nikol'skiy), G. S. Sinitsyna, and D. M. Ziv. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 141-52(1958).

The Nernst electrochemical equation was found to apply to very dilute Po solutions down to a concentration of 5×10^{-14} M at constant ionic strength. The valences of Po in its stable and reduced forms in solution were determined to be +4 and +2, respectively. The normal electrode potentials of tetravalent (Po/Po^{4+}) and divalent (Po/Po^{2+}) were determined to be $+0.765 \pm 0.005$ and $+0.68 \pm 0.01$ v, respectively. (D.L.C.)

22217 (AEC-tr-4474(p.184-90)) EFFECT OF THE NATURE AND CONCENTRATION OF THE ACID ON MAGNITUDE OF ELECTRODE POTENTIAL OF POLONIUM. B. P. Nikol'skii (Nikol'skiy), D. M. Ziv, B. I. Shestakov, and G. S. Sinitsyna. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 153-7(1958).

The electrochemical potential of Po separation was found to depend on the nature and concentration of acid. In experiments with HNO_3 , HCl, and CH_3COOH , the potential was found to increase with acid concentration due to formation of either Po ions of higher valence (as in the case of HNO_3) or of complex ions. For 0.001 N HNO_3 , most of Po is in the 4+ state, whereas in 1.5 N HNO_3 it is in the 6+ state. (D.L.C.)

22218 (AEC-tr-4474(p.191-6)) UTILIZATION OF THE ELECTROCHEMICAL METHOD FOR DETERMINATION OF SOLUBILITY OF POLONIUM HYDROXIDE. D. M. Ziv, V. S. Ziv, and G. S. Sinitsyna. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 158-62(1958).

The solubility of the hydrolysis product of Po(IV) salt, presumed to be the hydroxide, was determined by the electrochemical method and found to be on the order of 10^{-10} moles/liter. (D.L.C.)

22219 (AEC-tr-4474(p.197-200)) DISMUTATION OF SOLUTIONS OF TETRAVALENT POLONIUM. D. M. Ziv, N. S. Kolensikova, and G. S. Sinitsyna. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 163-5(1958).

A starting solution of 10^{-8} M Po concentration was prepared, and a working solution of 1.37×10^{-12} M Po was made up from the starting solution and its cathodic separation potential determined. It was found to correspond to pure Po^{4+} . After 56 days, the procedure was repeated, and potentials were found corresponding to Po^{6+} and Po^{2+} . The concentrations of Po^{6+} and Po^{2+} in the solution were found to be half of the total Po concentration; this is evidence for the dismutation of Po^{4+} to form Po^{6+} and Po^{2+} . A dismutation constant of 10^{-8} is calculated from the assumption that a state of equilibrium exists in the solution. (D.L.C.)

22220 (AEC-tr-4474(p.201-5)) NEW PROCEDURE FOR THE PREPARATION OF DERIVATIVES OF TETRAVALENT URANIUM. A. A. Grinberg, G. I. Petrzhak, L. E. (Ye.) Nikol'skaya, B. V. Ptitsyn, and F. M. Filinov. Translated from Trudy Radiovogo Inst. im. V. G. Khlopina, 8: 166-9(1958).

Methods are outlined for precipitating the oxalate or fluoride of uranium(IV) from solutions of uranium(VI) salts. In these methods, uranium(VI) is reduced to the (IV) state by Rongalite ($\text{NaHSO}_2 \cdot \text{CH}_2\text{O} \cdot 2\text{H}_2\text{O}$) in HNO_3 solution and then precipitated by $\text{H}_2\text{C}_2\text{O}_4$ or HF. The composition of the precipitated oxalate corresponds to $\text{U}(\text{C}_2\text{O}_4)_2 \cdot 6\text{H}_2\text{O}$. (D.L.C.)

22221 (AEC-tr-4474(p.206-14)) THE QUANTITATIVE SEPARATION OF ACTINIUM FROM RADIOACTINIUM AND

ACTINIUM X. I. E. (Ye.) Starik, A. S. Starik, E. (Ye.) A. Yashugina, and E. (Ye.) A. Smirnova. Translated from Trudy Radietvogo Inst. im. V. G. Khlopina, 8: 170-6(1958).

A method is outlined for separating actinium from radium and thorium isotopes. In this method, a lanthanum oxalate carrier is used to separate actinium from radium isotopes (AcX), and peroxide precipitation is used to separate thorium isotopes (RdAc) from actinium. Results are presented for a uranium pitchblende treated with this method; the amount of actinium free from RdAc and AcX is 92%. (D.L.C.)

22222 (AEC-tr-4474(p.215-29)) SEPARATION OF URANIUM AND THORIUM IN ANION-EXCHANGERS OF THE WEAK-BASE TYPE. B. P. Nikol'skii (Nikol'skiy), V. I. Paramonova, and A. F. V'yugina. Translated from Trudy Radietvogo Inst. im. V. G. Khlopina, 8: 177-88(1958).

The effects of solution pH and addendum concentration on the absorption of U and Th from acetate solutions by Wofatit M anion exchanger (weak base type) were investigated. U was found to be absorbed by Wofatit M considerably better than Th, and enrichment of 10 to 20 times could be obtained with solutions of pH 3 to 4. Elution of the absorbed ions by 0.2 N HCl also resulted in some enrichment. Both acetate- and chloride-treated Wofatit M forms were studied. Other anion exchangers were investigated and found to be inferior in absorbability to Wofatit M. (D.L.C.)

22223 (AEC-tr-4474(p.230-9)) CHROMATOGRAPHIC SEPARATION OF URANIUM AND THORIUM BY MEANS OF ION-EXCHANGE RESINS. B. P. Nikol'skii (Nikol'skiy) and A. M. Trofimov. Translated from Trudy Radietvogo Inst. im. V. G. Khlopina, 8: 189-97(1958).

A study was made of the absorption of U and Th by sulfonate cation exchange resins from nitrate solutions of different pH values. Separation of U and Th can be effected with 0.05 to 1.0 N HCl or HNO₃ solutions (selective absorption of Th) or with solutions of pH 3.8 to 5.0 (selective absorption of U). (D.L.C.)

22224 (AEC-tr-4631) INVESTIGATION OF THE SYNTHESIS REACTION OF STRONTIUM TITANATE. Jadwiga Wojciechowska. Translated for Oak Ridge National Lab. from Roczniki Chem., 27: 218-28(1953). 30p.

The synthesis reaction of strontium titanate, SrCO₃ + TiO₂ → SrTiO₃ + CO₂, in an equimolar mixture was investigated. Selectively acting reagents were used. Differential thermal analysis and qualitative determination of diffusion were carried out. Analytical findings were confirmed by x-ray tests. (auth)

22225 (AEC-tr-4652) CHEMICAL REACTIONS IN HETEROGENEOUS PHASES. A NEW CONCEPT: "THE EQUIVALENT VOLUME." Felix Trombe and Marc Foex. Translated from Ann. chim. (Paris) (11), 18: 97-122(1943). 16p.

In a study of chemical reactions, a general consideration is given for each body or compound at an interval of temperature such that reaction proceeds slowly if certain known conditions of volume are realized. The reaction between silica glass and fused Al is examined and is presented as an example. (J.R.D.)

22226 (AEC-tr-4654) NITRIDES OF THE RARE EARTH METALS. W. Klemm and G. Winkelmann. Translated from Z. anorg. u. allgem. Chem., 288: 87-90(1956). 5p.

The nitrides of the rare earth metals were prepared by reaction of mixtures of finely powdered rare earth metals and potassium chloride with ammonia. The lattice constants of these nitrides were determined. The special

position of trivalent gadolinium was shown during the study. (auth)

22227 (AEC-tr-4655) ON THE FORMATION OF CUBIC Ce₂O₃ IN THE OXIDATION OF CERIUM AND EVIDENCE FOR IT FROM ELECTRON DIFFRACTION. Robert Courtel and Jean Loriers. Translated from Compt. rend., 230: 735-7(1950). 2p.

The formation of cubic Ce₂O₃ in the oxidation of cerium was investigated. A technique of abrading in vacuum was used to remove the superficial film of oxide, completely limiting its renewal. The study of products formed on the surface of the cerium was effected in vacuum, by electron diffraction with a flat beam. Results indicated that Ce₂O₃ is the oxide which forms first on the metal. (M.C.G.)

22228 (AERE-Trans-861) THERMODYNAMICS OF GASIFICATION REACTIONS. N. V. Lavrov, V. I. Filippova, V. V. Korobov, and I. I. Chernenkov. Translated by J. B. Sykes from Trudy Inst. Goryuchikh Iskopaemykh, Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, 11: 24-9(1959). 9p.

Thermodynamic quantities were calculated for gasification reactions using more recent data. The reactions considered were combustion of coal, oxidation of coal by water vapor, and dissociation and conversion of methane. The equilibrium constants and their logarithms are given for each of these reactions. (M.C.G.)

22229 (CEA-tr-R-1050) ETUDES DES REACTIONS D'ECHANGE ISOTOPIQUE DU ¹⁴C ENTRE LE CNK ET LEURS APPLICATIONS A LA PREPARATION DU CNK MARQUE AU ¹⁴C. (Study of the Isotopic Exchange Reactions Between C¹⁴ and KCN and Applications to Preparation of KCN-C¹⁴). O. I. Andreeva and G. I. Kostikova. Translated into French from Conference on Radioisotopic Applications in the Physical Sciences and Industry, Copenhagen, September 1960. 21p.

The isotopic exchange reaction of carbon between KCN and the carbonates of Li, Na, K, and Ba was studied. It was established that the exchange in the system KCN-BaCO₃ starts at 650°C and is completely finished at 800°C in two hours. The exchange in the system KCN-M₂CO₃ (where M is Li, Na, or K) starts at 550°C and attains 100% for Li₂CO₃ at 650°C and for Na₂CO₃ and K₂CO₃ at 700°C. The velocity constants of the isotopic exchange were determined, and the activation exchange value, which for the system KCN-BaCO₃ is approximately 45 kcal/mol and for KCN-Na₂CO₃ and K₂CO₃ is about 32 kcal/mol, was calculated. The conditions for the production of C¹⁴-labeled KCN by the method of isotopic exchange with subsequent separation of the KCN from the carbonate by extraction with liquid ammonia were established. The obtention of labeled KCN has a yield higher than 90% and contains more than 96% of the basic compound. (tr-auth)

22230 (NP-tr-505) PROCESSING TECHNIQUE IN OBTAINING NUCLEAR ENERGY. Werner Mialki. Translated from Maschinenbau-Verfahrenstechnik-Werkstoffe, 83: No. 2, 37-49(1959). 51p.

The preparation of fissionable material from the time it is mined until it is finished for use as a fission material and the processing of fission products are discussed. (W.L.H.)

22231 (SCL-T-366) ORGANIC POLYMERS WITH ELECTRICAL AND MAGNETIC PROPERTIES. V. D. Bitiukov. Translated by Marcel I. Weinreich from Vestnik Akad. Nauk S.S.S.R., 30: No. 7, 99-100(July 1960). 4p.

A review of syntheses and investigations of organic polymers with new electric and magnetic properties is presented together with a report of the meeting of Jan. 21

to 22, 1960, held at the USSR Institute of Electrochemistry. Semiconducting polymers are considered in particular. (D.L.C.)

22232 MODIFICATIONS TO AN IONIZATION DETECTOR CHROMATOGRAPH FOR HIGH TEMPERATURE GAS-LIQUID CHROMATOGRAPHY EXPLORATORY STUDIES. B. J. Gudzinowicz and W. R. Smith (Monsanto Chemical Co., Everett, Mass.). *Anal. Chem.*, 33: 1135-6 (July 1961).

In initial high-temperature gas-liquid chromatography studies using an ionization detector chromatograph, hydrocarbons of lower molecular weight and complex aromatic mixtures, with some components having boiling points above 500°C, were resolved and determined. Preliminary quantitative investigations were completed using microgram quantities of organics with accuracy and precision comparable to those obtained with conventional instruments. (L.T.W.)

22233 THE OXIDATION OF POLYCRYSTALLINE BERYLLIUM IN CARBON DIOXIDE. W. J. van Peer (Australian Atomic Energy Commission, Sidney). *Australian J. Phys.*, 14: No. 1, 191-2 (Mar. 1961).

The growth rate and structure of BeO on polycrystalline Be surfaces is studied, in an atmosphere of moist CO₂ at 700°C and 1 atm. The Be samples are produced by hot pressing of Be powder. The BeO layers are studied by weight gain vs. time methods, and by electron and x ray diffraction analysis. Measurements are taken from 10 min to several hours after exposure to the CO₂ atmosphere. The BeO layers are found to grow with a preferred 001 orientation. (T.F.H.)

22234 THE OSMOTIC AND ACTIVITY COEFFICIENTS OF SOME BOLAFORM SULFONATES. O. D. Bonner and O. C. Rogers (Univ. of South Carolina, Columbia). *J. Phys. Chem.*, 65: 981-6 (June 1961).

These data were determined for the more concentrated solutions by isopiestic comparison of solutions of the sulfonates with solution of sodium chloride or lithium chloride. A specially constructed vapor pressure comparison apparatus was used for comparisons of the dilute solutions. The sulfonate groups appear to act osmotically independent of one another at high concentrations where 1/K is small relative to the distance of separation. In dilute solutions the separation of the anionic groups results in osmotic coefficients larger than for normal 2,1 electrolytes. There appears to be micelle formation in disulfonates where the groups are separated by several methylene linkages. (auth)

22235 THE CONDUCTANCES OF A NUMBER OF ACIDS AND DIVALENT METAL SALTS IN ANHYDROUS ETHANOLAMINE. Philip W. Brewster, Frederic C. Schmidt, and Ward B. Schaap (Indiana Univ., Bloomington). *J. Phys. Chem.*, 65: 990-2 (June 1961).

The conductances of solutions of three halogen acids, benzoic acid, some simple salts of strontium and barium, and salts of lead were studied in anhydrous ethanolamine. The phoreograms in the dilute regions are normal in the case of the alkaline earth metal salts, but have positive slopes in the case of the acids and the lead salts. An explanation for these cases is suggested in terms of suppression of solvent ionization and complex ion formation. (auth)

22236 POLAROGRAPHIC AND ACID PROPERTIES OF THORIUM PERCHLORATE IN ACETONITRILE. I. M. Kolthoff and S. Ikeda (Univ. of Minnesota, Minneapolis). *J. Phys. Chem.*, 65: 1020-6 (June 1961).

Thorium perchlorate in acetonitrile (AN) behaves like a relatively strong dibasic acid with a first dissociation constant of about 10^{-4} . The second dissociation constant is

much greater than that of sulfuric acid. It was indicated that the Th(ClO₄)₂²⁺ ion is relatively stable in AN. The neutralization product formed upon titration with diphenylguanidine and the insoluble reaction product formed in electrolysis at -1.8 volt (vs. s.c.e.) both contain about 2 ClO₄⁻ per one thorium. The height of the polarographic wave of thorium perchlorate in AN is proportional to concentration. The reduction involves the evolution of hydrogen and not the formation of thorium amalgam. The value of the limiting current corresponds to the formation of a reaction product which contains about 2 ClO₄⁻ per one thorium. (auth)

22237 DEUTERIUM ISOTOPE EFFECTS ON DISSOCIATION CONSTANTS AND FORMATION CONSTANTS. Norman C. Li, Philomena Tang, and Raj Mathur (Duquesne Univ., Pittsburgh). *J. Phys. Chem.*, 65: 1074-6 (June 1961).

Acid dissociation constants of several organic acids containing different functional groups were determined from the study of the relation between true and apparent pH of solutions in D₂O. Formation constants of metal complexes of some of the organic acids were determined in D₂O by polarography. It was demonstrated experimentally that the deuterium isotope effect on acid dissociation constant can be attributed to the specific bond affected. (P.C.H.)

22238 POLAROGRAPHY IN WATER AND WATER-ETHANOL. I. URANIUM(VI) IN CHLORIDE AND PERCHLORATE MEDIA IN ONE MOLAR ACID. William Ves Childs and Edward S. Amis (Univ. of Arkansas, Fayetteville). *J. Phys. Chem.*, 65: 1080-1 (June 1961).

The polarographic reduction of U⁶⁺ was studied in 1 M acid solution in water, ethanol, and water-ethanol media as a function of the chloride, ethanol, and uranyl concentrations. The diffusion current, *i*_d, was measured at -0.4 v vs. the saturated calomel electrode using a saturated lithium acetate solution as a salt bridge. Using the Ilkovic equation, the diffusion current, *I*, was calculated. (P.C.H.)

22239 INVESTIGATION OF HIGH-TEMPERATURE MODIFICATION OF BERYLLIUM OXYACETATE. K. N. Semenenko (Moscow State Univ.). *Zhur. Strukt. Khim.*, 1: 442-6 (Nov.-Dec. 1960). (In Russian)

Polymorphism of beryllium oxyacetate at temperatures above 145 to 148° was investigated by a Debye x-ray method. The correlation between monoclinic β and γ modifications of rhombic symmetry was established. (tr-auth)

22240 REPORT OF THE NATIONAL CHEMICAL LABORATORY 1960. Report of the Steering Committee and Report of the Director of the National Chemical Laboratory for 1960. London, Her Majesty's Stationery Office, 1961. 74p. \$0.63.

The laboratory's research program for Jan. 1 to Dec. 31, 1960, is described. The work done by various groups on chemical thermodynamics, new materials, extraction of metals, inorganic chemistry, and metal corrosion is reviewed. Possibilities of increasing personnel and expanding laboratory sites for future work are also discussed. Also included are lists of personnel, publications, and patents. (P.C.H.)

Analytical Procedures

22241 (AERE-AM-78) THE DETERMINATION OF COMBINED NITROGEN IN ZIRCONIUM AND ZIRCALOY. C. F. Bush (United Kingdom Atomic Energy Authority, Research Group, Chemistry Div., Chatham Outstation, Kent, England). Jan. 1961. 7p.

Zircaloy or Zr is dissolved in hydrofluoric acid, resulting in the conversion of nitrogen to ammonium fluoride.

After the addition of excess sodium hydroxide solution, the ammonia is distilled off and determined absorptiometrically by Nessler reagent. The method is suitable for the determination of up to 300 μg of nitrogen. The limit of detection is dependent on the purity of the reagents. In this range, the error, except in the lowest levels, should not exceed 5%. (auth)

22242 (BM-RI-5814) SPECTROCHEMICAL ANALYSIS OF HIGH-PURITY TUNGSTEN. R. W. Lewis, C. F. Earl, J. L. Potter, and J. R. Wells (Bureau of Mines, Boulder City Metallurgy Research Lab., Nev. and Bureau of Mines, Reno Metallurgical Research Center, Nev.). Jan. 1961. 14p.

A spectrochemical method for determining the concentrations of 19 impurities in high-purity tungsten is described. Metal samples were thermally converted to the oxide, mixed with graphite, which was prepared and mixed with an internal-standard element, and excited in a d-c arc. Sixteen of the impurity elements were determined with one set of conditions, using germanium as an internal standard. Lanthanum was used as an internal standard in the tests for boron and chromium. Molybdenum required the substitution of sodium chloride for the graphite and the use of copper electrodes. Data on the precision of the method are included. The coefficients of variation varied considerably but averaged about 15%. Higher concentrations of impurities than those investigated may be determined with some modification of the testing procedure. (auth)

22243 (CEA-1908) QUELQUES REMARQUES SUR LA METHODE "CARRIER DISTILLATION." R. Avni and M. Chaput (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1961. 24p.

The method of Scribner and Mullin makes possible the spectrographic analysis of the refractory oxides of uranium and plutonium. It uses a distillation of the elements, which is more or less selective. The influence of the carrier is the subject of as many hypotheses as there are parameters involved in the process. The measurements of the arc temperature carried out on the leading edges of the vibration bands and of certain copper lines have made it possible to show the influence of the nature of the carrier and to establish a relation between the values of the excitation potentials of the atoms and the temperatures produced. This result makes it possible to explain certain contradictions between the principle of a fractional distillation in the arc which is incompatible with the refractory properties of certain elements and their spectrographic sensitivity. (auth)

22244 (HW-SA-2208) THE DETERMINATION THORIUM ISOTOPIC RATIOS BY RADIOCHEMICAL METHODS. W. Y. Matsumoto (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [1960?]. 21p.

Presented at the Northwest Regional Meeting of the American Chemical Society, Portland, Oregon, June 15, 16, 1961.

A sensitive analytical method was needed to determine the total thorium content and the Th^{230} isotopic abundance in a number of uranium ore and mill tailing samples available in the United States. A procedure was developed using absolute alpha counting to determine Th^{230} and neutron activation analysis to determine Th^{232} . The method is highly specific with a sensitivity on the order of 10^{-10} grams for either isotope and was found to give reliable data for the various sample types of interest. (auth)

22245 (IEA-41) DOSEAMENTO DE F6SFORO, AO NIVEL DE PARTES POR MILHÃO, EM COMPOSTOS DE

URÂNIO ATOMICAMENTE PUROS, PELO MÉTODO DE DILUIÇÃO ISOTÓPICA. (Determination of Phosphorus, at the Level of Parts per Million, in Atomically Pure Uranium, Using the Isotopic Dilution Method). Fausto W. Lima and Laura Tognoli Attala (Sao Paulo, Brazil. Universidade. Instituto de Energia Atômica). 1961. 18p.

Application is made of the isotopic dilution method to phosphorus analysis when this element is present at the level of ppm in uranium compounds. The efficiency of the method is checked by analysis of samples of sodium phosphate with known amounts of phosphorus, as well as by analysis of samples of uranium with known amounts of phosphorus. The experimental method is described. The method is being used to analyze various batches of atomically pure uranium produced by the Uranium Pilot Plant of the Instituto de Energia Atômica. (auth)

22246 (K-1476) GRAVIMETRIC FACTORS FOR URANIUM IN SELECTED COMPOUNDS. W. D. McCluen and F. H. Anderson (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 15, 1961. Contract W-7405-eng-26. 29p.

Revised gravimetric factors for theoretically pure uranium compounds are presented. Chemical atomic weights for uranium are based on the most recently reported nucleic masses of the uranium isotopes. Atomic weights for all other elements are those accepted by the International Commission on Atomic Weights. These factors recognize the presence of uranium isotopes 234 and 236 as they exist in the gaseous diffusion complex. (auth)

22247 (KAPL-M-SLJ-1) THE ALUMINUM ELECTRODE AS AN INDICATOR OF CHLORIDE CONCENTRATION. S. L. Jones (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 30, 1961. Contract W-31-109-ENG-52. 11p.

A method for determining chloride ion concentration in aluminum capacitor forming electrolytes by the effect of the chloride ion upon the rate of development of the formation voltage was previously reported in the literature. Although the sensitivity of the method was reported to be as low as 0.02 parts per million of chloride in hot 10% boric acid forming electrolyte, the ions present in boiler water were found, in this present study, to interfere seriously with the determination. (auth)

22248 (LA-2540) DETERMINATION OF IMPURITIES IN HELIUM. George E. Meadows, Grant L. Hubbard, and Harold M. Busey (Los Alamos Scientific Lab., N. Mex.). Apr. 15, 1960. Contract W-7405-Eng-36. 23p.

Analytical equipment was assembled for the testing of cover gas purity for nuclear reactors where extremely pure inert gases are needed. Helium can be analyzed for water, oxygen, nitrogen, hydrogen, and the inert gases in the 1 to 20 volume parts per million range. Both an electrolytic moisture tester and a gas chromatograph using a very sensitive thermal conductivity detector are used. Helium streams of known compositions of trace impurities were prepared. Methods of concentrating impurities for the greatest analytical sensitivity were studied. (auth)

22249 (NP-10350) SEPARACION Y DETERMINACIÓN DE URANIO (VI) EN PRESENCIA DE URANIO (IV) Y OTROS CATIONES. INFORME NO. 48. (Separation and Determination of Uranium(VI) in Presence of Uranium(IV) and Other Cations. Report No. 48). Jorge Alberto Blay (Argentina. Comisión Nacional de Energia Atomica, Buenos Aires). 1960. 16p.

Uranium(VI) was separated by chromatographic methods from uranium(IV), iron(II, III), vanadium(III, IV, V), molybdenum(IV, VI), and copper(II) with a cationic exchange

resin and elution with a mixture of sulfuric and phosphoric acids. The amount was determined photocolormetrically by the peroxide method. The determination of the total uranium was possible if the sample was previously oxidized. The accuracy of the determinations was $\pm 0.5\%$ for the percentage of reduced uranium and $\pm 2\%$ for total uranium. The method was used with success in uranium analysis of leaching liquors obtained from Malargüe ores. (auth)

22250 (PG-Report-200) ANALYTICAL METHOD FOR THE FLUORIMETRIC DETERMINATION OF TRACE AMOUNTS OF URANIUM IN EFFLUENT TREATMENT PLANT SOLUTIONS. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1961. 7p.

The sample is evaporated to dryness, the residue fused with a sodium fluoride/sodium bicarbonate mixture and the uranium is measured fluorimetrically. The method is suitable for the determination of uranium in samples from the effluent treatment plant. (auth)

22251 (PG-Report-202) ANALYTICAL METHOD FOR THE DETERMINATION OF CAESIUM-137 IN REACTOR FUEL PROCESSING AND EFFLUENT TREATMENT PLANT SOLUTIONS. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1961. 8p.

Cesium-137 with added carrier is separated by ion exchange. Cesium perchlorate is weighed and its gamma activity is measured. Bias is less than 2 to 3%. Precision is $\pm 8\%$ at the 10^5 dpm level. Concentration range is dependent on preliminary dilution of the sample. Not more than 2 milliequivalents of anion other than hydroxyl should be present otherwise the effectiveness of the column may be impaired. (auth)

22252 (CEA-tr-R-1259) DOSAGE COLORIMETRIQUE DE L'OXYDE D'HAFNIUM DANS UN MELANGE AVEC L'OXYDE DE ZIRCONIUM. (Colorimetric Determination of Hafnium Oxide in Mixture with Zirconium Oxide). L. I. Kononenko, R. S. Lauer, and N. S. Poluektov. Translated into French from Ukrain. Khim. Zhur., 25: No. 5, 25-9 (1959). 15p.

The composition, apparent dissociation constants, and the behavior, as a function of the increase of acidity, of colored complexes of zirconium and hafnium with arsenazo were studied. The two elements give complexes containing two molecules of arsenazo for one atom of the metal. The apparent dissociation constant of the hafnium compound in $0.25N$ HCl is 7.2 times greater than in the case of the zirconium compound. When the concentration of HCl increases to $1N$, the intensity of the coloration of the hafnium complex becomes 19 times weaker, whereas the coloration of the zirconium compound decreases only two times. It was shown that by utilizing the properties of the compounds formed by the arsenazo with the metals, the concentration of hafnium oxide between 20 and 100% can be determined approximately in a mixture with zirconium oxide. (tr-auth)

22253 (CEA-tr-R-1275) SUR LA METHODE DE DOSAGE DE PETITES QUANTITES DE SUBSTANCES A RADIOACTIVITE α , AVEC EMPLOI DE PHOTOEMULSIONS NUCLEAIRES. (On a method for Determination of Small Quantities of α -active Substances, Using Nuclear Photo-emulsions). K. B. Zaborenko and V. I. Korobkov. Translated into French from Radiokhimiya, 1: 724-7(1959). 14p.

The possibility of a quantitative determination of small quantities of α -emitting substances by the use of nuclear emulsions was tested on a uranium sample. It was found that during the impregnation of the emulsion with a solution of uranium the uranium absorption is characterized by the

penetration coefficient (absorption coefficient) which depends on the pH of the solution. (tr-auth)

22254 (JPRS-4546) PROGRESS OF ANALYTICAL CHEMISTRY IN 1959. A. K. Babko. Translated from Zavodskaya Lab., 26: 679-703(1960). 42p.

A survey of the development of analytical chemistry in 1959 is presented, with emphasis on the rare earths. The survey is divided into sections dealing with precipitation, complexes, catalytic reactions, extraction, titration, and photometry. (277 references) (D.L.C.)

22255 SPECTROPHOTOMETRIC EXTRACTION METHOD SPECIFIC FOR PLUTONIUM. William J. Maack, Maxine Elliott Kussy, Glenn L. Booman, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 33: 998-1001(July 1961).

A spectrophotometric extraction method for milligram levels of plutonium is described. Following a silver (II) oxidation, plutonium(VI) as the tetrapropylammonium trinitrate complex is extracted quantitatively into methyl isobutyl ketone from an acid-deficient aluminum nitrate salting solution. Though uranium and neptunium are extracted also, their spectra are sufficiently discrete so that a direct absorbance measurement of the separated organic phase can be made for plutonium in the presence of the other two actinides. The method is fast, gives excellent decontamination from fission product nuclides, and is virtually free of diverse ion interference. It is applicable to the range of 2.0 to 15 mg of plutonium with a 0.3% standard deviation of the 12.3-mg level, comparing favorably with redox titrimetric and coulometric methods. A method for the simultaneous determination of plutonium and uranium is described. (auth)

22256 QUANTITATIVE RADIOCHEMICAL ANALYSES BY ION EXCHANGE. SODIUM AND CESIUM. Leon Wish (U. S. Naval Radiological Defense Lab., San Francisco). Anal. Chem., 33: 1002-3(July 1961).

In the quantitative radiochemical analytical procedure for fission product radionuclides, the alkali metal, alkaline earth, and rare earth activities are adsorbed on a cation column. The alkali metals and rare earths are eluted together before the separation of the individual alkaline earths. To determine the sodium and cesium activities, a separation from the rare earths and from each other is necessary. By using solutions of sodium and ammonium chloride it was shown that sodium and cesium activities could be eluted individually from the cation column. The subsequent rare earth and alkaline earth separations were not affected. (auth)

22257 RADIOCHEMICAL DETERMINATION OF TOTAL RARE EARTHS BY LIQUID-LIQUID EXTRACTION. J. J. McCown and R. P. Larsen (Argonne National Lab., Ill.). Anal. Chem., 33: 1003-5(July 1961).

A rapid and quantitative radiochemical method for the determination of rare earth activities produced in nuclear fission is based on the extractability of the rare earths with bis(2-ethylhexyl)orthophosphoric acid. The extraction procedure affords excellent separations from the other fission elements as well as a considerable saving in time and effort. (auth)

22258 DETERMINATION OF POTASSIUM IN SILICATE MINERALS AND ROCKS BY NEUTRON ACTIVATION ANALYSIS. John W. Winchester (Massachusetts Inst. of Tech., Cambridge). Anal. Chem., 33: 1007-12(July 1961).

The determination of potassium in natural silicate minerals by pile neutron activation and by counting the induced β radiation in the irradiated specimen without chemi-

processing is described. An end-window proportional counter and aluminum absorbers are used for radioactivity measurement. Precision and absolute accuracy of the method are of the order of 1%, and interference by trace elements in general is less than this. Results are presented for the analysis of the standard granite G-1, diabase W-1, argillaceous limestone NBS No. 1a, feldspar NBS No. 70, and biotite M.I.T. No. B3203. (auth)

22259 X-RAY ABSORPTION EDGE DETERMINATION OF URANIUM IN COMPLEX MIXTURES. E. A. Hakkila (Los Alamos Scientific Lab., N. Mex.). *Anal. Chem.*, 33: 1012-15 (July 1961).

Uranium in the concentration range between 0.5 and 40 mg per ml is determined by an x-ray absorption edge procedure. In this procedure a molybdenum-niobium target is bombarded by the radiation from a tungsten-target x-ray tube and the intensities of the fluorescent x-rays of molybdenum and niobium are measured after they have passed through an absorption cell filled with the sample solution. The measured intensities are compared to the intensities transmitted through the same cell filled with water. The L_{III} absorption edge for uranium occurs at a wave length between the wave lengths of the fluorescent x-rays from the target, and the transmitted intensities are related to uranium concentration by standard absorption principles. For determining between 0.5 and 40 mg of uranium per ml the relative standard deviation of the method varies from 6 to 0.34%. Defining sensitivity as that concentration of uranium equivalent to three times the standard deviation of determining a blank, 0.06 mg of uranium per ml can be measured when a cell of 3-cm path length is used. Only yttrium interferes seriously with the procedure. Approximately 5 minutes are required to convert the instrument from normal x-ray fluorescence operation to absorption edge analysis. Twenty to forty analyses can be performed daily. (auth)

22260 COULOMETRIC DETERMINATION OF URANIUM(IV) BY OXIDATION AT CONTROLLED POTENTIALS.

J. M. Boyd and Oscar Menis (Oak Ridge National Lab., Tenn.). *Anal. Chem.*, 33: 1016-18 (July 1961).

A controlled-potential coulometric method is described for the titration of uranium(IV). At potentials more positive than ± 0.5 volt vs. the Ag/AgCl electrode, uranium(IV) is oxidized at a platinum electrode. The oxidation is sufficiently rapid and complete at a potential of +1.4 volts for use in the titration of uranium, although the uranium(IV)/U(VI) couple is not reversible. The method has been applied to the determination of uranium(IV) in samples of UO_2 and in ThO_2-UO_x mixtures dissolved in H_3PO_4 . From 0.5 to 10 mg of uranium(IV) in 1 M solutions of H_3PO_4 , H_2SO_4 , ClO_4 , or HNO_3 can be determined by this method with a coefficient of variation of 0.3%. (auth)

22261 THERMOGRAVIMETRIC BEHAVIOR OF PLUTONIUM METAL, NITRATE, SULFATE, AND OXALATE. Glenn R. Waterbury, Robert M. Douglass, and Charles F. Metz (Los Alamos Scientific Lab., N. Mex.). *Anal. Chem.*, 33: 1018-23 (July 1961).

A thermobalance for analysis of plutonium samples is described. Thermogravimetry curves for plutonium metal and its nitrate, sulfate, and oxalate were determined in air at temperatures between 20° and 1250°C, and the oxides produced were examined microscopically and by x-ray powder diffraction. No conclusive evidence of formation of suboxides of plutonium was observed. The final dioxides from all samples except the nitrate contained excess oxygen after 4 hours at 1250°C, indicating that a higher tem-

perature is required to form the stoichiometric dioxide by ignition of these materials in air. The ignition products of the nitrate were slightly deficient in oxygen, having an O/Pu atom ratio of 1.989. The crystal structure of all of the products was face-centered isometric, fluorite type, with $a_0 = 5.395 \pm 0.001$ Å. Only the sulfate formed a stable intermediate, anhydrous plutonium sulfate, which might be used in the gravimetric determination of plutonium. (auth)

22262 VOLTAGE SCANNING COULOMETRY FOR THE DETERMINATION OF TRACES OF IRON. F. A. Scott, R. M. Peekema, and R. E. Connally (General Electric Co., Richland, Wash.). *Anal. Chem.*, 33: 1024-7 (July 1961). (HW-SA-1848)

Blanks equivalent to 0.2 μ eq. establish the detection limit of many controlled potential coulometric procedures. To permit lower detection limits, in the region of 10^{-3} μ eq., a new electroanalytical technique called voltage scanning coulometry has been developed and its parameters investigated. The procedure is based upon the measurement of the electrolysis current passed while the potential between the sample solution and a working or titrating electrode is scanned at a uniform rate. During the scan, every effort is made to eliminate concentration polarization of the working electrode, and a complete titration is, therefore, effected. The major portion of the current due to the blank is distributed uniformly along the curve and can be distinguished readily from the current due to the titration which appears as a peak. The procedure and apparatus are simple and the determination is rapid. The method has a specificity similar to that of derivative polarography. Several possible applications of the technique are suggested, and its use in the determination of trace quantities of iron is discussed in detail. A detection limit for iron of 5×10^{-4} μ eq. (0.025 μ g.) per sample or, assuming a 5-ml sample, of 10^{-7} M and a standard deviation of ± 0.02 μ g. have been obtained. Possible refinements to improve further the sensitivity are indicated. (auth)

22263 EMISSION SPECTROMETRIC DETERMINATION OF OXYGEN IN NIOBIUM METAL. F. Monte Evens and Velmer A. Fassel (Ames Lab., Ames, Iowa). *Anal. Chem.*, 33: 1056-9 (July 1961). (IS-237)

The emission spectrometric technique for the determination of oxygen in metals has been extended to the determination of oxygen in niobium. A d.c. carbon-arc discharge is used to extract the oxygen content of the sample as carbon monoxide into a static argon atmosphere. Special electrode assemblies which support a platinum-niobium alloy or provide a critical graphite-niobium relationship are employed. The d.c. carbon arc dissociates the evolved carbon monoxide and the emission spectrum of atomic oxygen is excited. The intensity ratios of O_{7772A}/Ar_{7891A} and O_{7775A}/Ar_{7891A} are related to the oxygen content of the samples. The concentration range from 0.004 to 0.60 weight % can be covered. The preparation and evaluation of synthetic oxygen standards are discussed. (auth)

22264 TRIPHENYL PHOSPHITE, A SELECTIVE EXTRACTANT FOR COPPER(I) HALIDES. Thomas H. Handley (Oak Ridge National Lab., Tenn.) and John A. Dean. *Anal. Chem.*, 33: 1087-91 (July 1961).

Triphenyl phosphite dissolved in CCl_4 selectively extracts copper(I) from various halide systems. The influence of a wide range of halide ion, reagent, and copper concentrations, and the effect of temperature and diverse anions and cations have been investigated. In the range 0.07 to 0.15 M halide ion and with a 10% reagent concen-

tation, distribution coefficients exceed 500 for KBr, KCl, and NH_4Cl systems, and 100 for NaCl and HCl systems. Reduction is accomplished by heating with ascorbic acid at 60°C ; after cooling to 25°C , the extraction is accomplished in a single, 10-minute equilibration. The copper is easily stripped from the organic phase. From $0.003\text{ }\mu\text{g}$ to 30 mg of copper per 5 ml can be handled with 5 ml of 10% reagent. (auth)

22265 SPECTROPHOTOMETRIC DETERMINATION OF COBALT WITH 1, 2, 3-CYCLOHEXANETRIONE TRIOXIME. W. Joe Frierson, Nancy Patterson, Harriet Harrill, and Nina Marable (Agnes Scott Coll., Decatur, Ga.). *Anal. Chem.*, 33: 1096-8 (July 1961).

The purpose of this investigation was to study the reactivity of 1, 2, 3-cyclohexanetrione trioxime with inorganic ions, in particular the cobalt(II) ion which reacts with it to give a stable yellow complex. This complex does not give an absorption maximum, but shows increased absorbance from 575 to $375\text{ m}\mu$. The wave length selected for this study was $400\text{ m}\mu$, since the reagent shows essentially no absorbance at this value. The reaction is carried out in a solution with the pH adjusted between 3 and 4. The optimum concentration range for cobalt in the colorimetric procedure developed is 1 to 4 ppm. Of the diverse ions checked, nickel, iron, and copper interfere. A preliminary study has been made of this reagent for the determination of these three elements. (auth)

22266 A SPECTROPHOTOMETRIC DETERMINATION OF RHENIUM. B. T. Kenna (Univ. of Arkansas, Fayetteville). *Anal. Chem.*, 33: 1130-1 (July 1961).

A spectrophotometric procedure was developed for rhenium which would not involve any special procedures such as solvent extraction to stabilize the color. The method is quick and reliable. The basis of the procedure is a qualitative scheme involving rhenium and several chemically similar elements. Rhenium is identified by the orange color produced on treating perrhenate ion with dimethylglyoxime and stannous chloride-hydrochloric acid solutions. (L.T.W.)

22267 DETERMINATION OF COPPER IN SUBMICROGRAM QUANTITIES BY NEUTRON ACTIVATION ANALYSIS. M. Widell and T. Westermarck (Royal Inst. of Tech., Stockholm). *Atompraxis*, 7: 201-6 (June 1961). (In English)

Activation analytical methods for copper, especially in submicrogram quantities, are reviewed. A procedure involving neutron activation, dissolution, selective copper precipitation (salicylaldoxime), and multi-channel NaI(Tl) gamma spectrometry is described. The method is applied to human cerebro-spinal fluid where an average copper content of $3 \times 10^{-7}\text{ g/g}$ was found. Future simplifications using recently available complex ion exchangers are possible. (auth)

22268 RADIOMETRIC DETERMINATION OF HIGHER SATURATED FATTY ACIDS ON PAPER CHROMATOGRAMS. R. Otto (Institut für angewandte Radioaktivität, Leipzig, Ger.). *Atompraxis*, 7: 209-12 (June 1961). (In German)

The quantitative determination of lauric, myristic, palmitic, and stearic acid on paper chromatograms, using Co^{60} is described. Mixtures of these acids are separated on paper with distribution chromatography by means of the descending method. The separated fatty acids are converted in situ with $\text{Co}(\text{CH}_3\text{COO})_2$ solution labeled with Co^{60} , the excess reagent is washed off with water, the cobalt soaps are made visible with amino sulfide solution, the chromato-

grams are cut into measurement strips, and the total count rates for the individual acids are determined. The amount of particular fatty acids can be calculated by radiometric evaluation of gaged strips on which known quantities are chromatographed and developed. (auth)

22269 ELEMENT ANALYSIS BY THE DETERMINATION OF THE ABSORPTION OF IONIZING RADIATIONS. L. Wiesner (Institut für Erdölforschung, Hanover). *Atomwirtschaft*, 6: 278-83 (May 1961). (In German)

Radiometric absorption analysis as compared with chemical methods is distinguished in a wide range of organic and inorganic applications for element analysis by speed and greater accuracy. Its practical application in petroleum research for various assays is described. Measuring equipment, radiation sources, and limits of accuracy are dealt with in detail. (auth)

22270 SPECTROPHOTOMETRIC DETERMINATION OF VANADIUM IN URANIUM METAL, ORES, AND LIQUORS. Allan W. Ashbrook and K. Conn (Eldorado Mining and Refining Ltd., Ottawa). *Chemist Analyst*, 50: 47-8 (June 1961).

Procedures which permit the rapid spectrophotometric determination of trace vanadium in uranium metal, ores, and liquors and are well suited to routine analyses are described. The procedure for uranium metal consists of dissolving a sample in HNO_3 and HClO_4 and evaporating almost to dryness. A sample of the solution containing up to $50\text{ micrograms V}_2\text{O}_5$ is transferred to a 125-ml separatory funnel, and the pH is adjusted to 4.0 with buffer and diluted, if necessary, to 50 ml with water. Then add 5 ml EDTA solution and shake 1 min ; add $5\text{ ml Th}(\text{NO}_3)_4$ solution and shake for 5 min . Add 20 ml ethanolic 8-quinolinol solution and 20 ml CCl_4 and shake 2 min allowing phase separation. Pass the lower CCl_4 phase through dry filter paper. Using 5-cm cells, measure the absorbance of the organic phase at 475 millimicrons against a reagent blank. Calculate the V_2O_5 result from a calibration curve. For ores, add 10 g of $\text{Na}_2\text{CO}_3\text{-K}_2\text{CO}_3$ to a sample and mix thoroughly. Cover the mixture and let it fuse 5 to 10 min . Allow the melt to cool, transfer to a beaker, and boil with water to dissolve the salts. Filter, and proceed with the clear filtrate as above to the separatory funnel. (N.W.R.)

22271 CHROMATOGRAPHIC SEPARATION OF ALKALI METAL IONS ON PAPER IMPREGNATED WITH AMMONIUM MOLYBDOPHOSPHATE. G. Alberti and G. Grassin (C.N.R.N., Rome). *J. Chromatog.*, 4: 423-5 (1960). (In English) (CNEN-49)

Strips of Whatman No. 1 filter paper, impregnated with 3.2 mg/cm^2 AMP, were used to determine the R_F values of alkali metal ions. The chromatograms were developed by the ascending method for 2 to 3 hr . With a suitable developing solvent, clear separation of any two ions is possible. The difficulty in obtaining a separation of the 5 alkali metals on the same strip at the same time with a single eluant is due to the considerable difference in the affinity of the AMP for the elements in question. A procedure for obtaining complete separation is given. (P.C.H.)

22272 THE ANALYSIS OF IMPURITIES IN CARBON DIOXIDE BY GAS-PHASE CHROMATOGRAPHY. Raymond Aubeau and Louis Champeix (C.E.N., Saclay, France). *Inds. atomiques*, No. 11/12: 9p. (1960). (CEA-1949) (In French)

The most frequently occurring impurities in CO_2 (H_2 , O_2 , N_2 , CH_4 , CO) analyzed by gas-phase chromatography using a column of the molecular sieve Linde 5 A. Two methods were used. In the sensitive method, the CO_2 is

condensed at liquid nitrogen temperatures (-196°C). The non-condensable impurities are then introduced alone into the chromatograph which separates them. With a volume of 250 ccs of CO_2 , it is possible to detect each impurity at minimum concentrations of 0.1 to 2 ppm approximately, depending on the impurity. In the rapid method, the CO_2 sample is completely introduced into the stream of carrier gas. A precolumn filled with silica gel separates the CO_2 from its impurities; these then pass alone into a column containing the molecular sieve 5 A which separates them as previously. Starting with a volume of 10 ccs of CO_2 each impurity can be detected at minimum concentrations of 1 to 70 ppm according to the nature of the impurity. (auth)

22273 DETERMINATION OF URANIUM AS PYRO-PHOSPHATE. J. S. Wright, T. J. Hayes, and J. A. Ryan (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.). *Nature*, 190: 1188-9 (June 24, 1961).

Uranium was precipitated at pH 5.5 from solutions containing EDTA, HNO_3 , and $(\text{NH}_4)_2\text{SO}_4$. The ignited precipitates were dissolved in concentrated H_3PO_4 and the solutions titrated with standard $\text{K}_2\text{Cr}_2\text{O}_7$ solutions. Results indicate that the most probable formula is $\text{UO} \cdot \text{UO}_2 \cdot \text{P}_2\text{O}_7 \cdot \text{U}^{4+}$, 34.10%; total U, 68.205%. With this formula quantitative recovery of uranium was obtained from solutions of known uranium content. (P.C.H.)

22274 DETERMINATION OF CERIUM IN MEDIUM AND HIGH ALLOY STEELS. A. A. Fedorov and F. A. Ozerskaya (I. P. Bardin Central Scientific Research Inst. of Ferrous Metallurgy, [USSR]). *Zavodskaya Lab.*, 27: 139-40 (1961). (In Russian)

In order to avoid the difficulty presented by the interference of several alloying components with the determination of cerium in steel, the specimen is dissolved in HF with addition of H_2O_2 and the Ce is precipitated with CaF_2 . The color reaction based on the formation of a yellow complex compound of tetravalent Ce when citric acid is added in alkaline solution in the presence of H_2O_2 is used for the colorimetric determination of the element. Addition of boric acid or of glycerin and Trilon B to the solution prevents coagulation of the $\text{Na}_3\text{Ce}(\text{C}_6\text{H}_5\text{O}_7)_3$ formed. The Ce may be determined also spectrographically, using the Ce fluoride precipitate calcined at 450 to 500°C . The method was used with good success in steel analysis. (TTT)

22275 SPECTROGRAPHIC DETERMINATION OF RHENIUM IN ALLOYS. I. P. Kharlamov, P. Ya. Yakovlev, and M. I. Lykova (I. P. Bardin Central Scientific Research Inst. of Ferrous Metallurgy and Experimental Scientific Research Inst. of Metal Cutting Machines). *Zavodskaya Lab.*, 27: 141-3 (1961). (In Russian)

The presence of Mo and W interferes with the color-forming reaction of penta- and hexavalent Rh ions with thiocyanates and must be eliminated prior to the colorimetric determination. In view of their instability, the Rh thiocyanate solutions do not follow the Lambert-Beer law and for this reason other color-forming agents, such as urea, methyl violet, and Na_2SO_3 were investigated. A new method was developed on the basis of the finding that K permanganate solutions have a strong absorption in the ultra-violet region, using it for determining this element in complex alloys containing more than 0.5% Rh. In the absence of NO_3^- ions the maximum lying at 228 $\text{m}\mu$ with a molar absorption coefficient of 3610 was used for the determinations. Tests have shown that the HNO_3 is completely eliminated at temperatures of 140 to 160°C without losses in Rh. Under these conditions, Al, Si, and W do not interfere with the measurements. (TTT)

General Inorganic and Physical Chemistry

22276 (IA-615) THREE PHASE FORMATION IN THE SYSTEM HYDROCHLORIC ACID-WATER-TRI-n-BUTYL PHOSPHATE-DILUENT. E. Foa, N. Rosintal, and Y. Marcus (Israel. Atomic Energy Commission, Tel-Aviv). *Apr. 1961.* 10p.

The formation of three liquid phases in the quaternary system hydrochloric acid-water-tri-n-butyl phosphate (TBP)-diluent was studied. The adduct $\text{TBP} \cdot \text{HCl}$ was identified by its infrared spectrum, and its stability measured. The solubility of this adduct in a TBP-diluent system was studied as function of diluent composition, concentration, and temperature. (auth)

22277 (IS-305) A MODEL OF A MASS SPECTROMETER TO SIMULTANEOUSLY COLLECT POSITIVE AND NEGATIVE IONS. Gerald D. Flesch and Harry J. Svec (Ames Lab., Ames, Iowa). [June 16, 1961]. Contract W-7405-eng-82. 12p.

A discussion is given of the design and operational characteristics of a mass spectrometer for the detection of positive and negative ions. The spectra obtained for ions from freon-12 and chromyl fluoride are described. (B.O.G.)

22278 (ORO-414) HIGH TEMPERATURE ELECTROMOTIVE FORCE MEASUREMENTS. [Final Report]. J. V. Vaughen (Stetson Univ., De Land, Fla.). [1961?]. Contract [AT(40-1)-2044]. 15p.

A discussion is given of the design of an electrocell for the measurement of high-temperature emf of electrodes up to 250°C . Graphical and tabular results are presented which show that pyrex is apparently a stable glass electrode for emf measurements in this range. (B.O.G.)

22279 (TID-12985) METAL CHELATES OF 4-HYDROXYBENZOTHAZOLE AND ITS DERIVATIVES (thesis). Pao-Kuo Feng (Pittsburgh. Univ.). 1961. Contract AT(30-1)-860. 169p.

4-Hydroxybenzothiazole was synthesized by Erlenmeyer's method with several modifications. A number of its derivatives were prepared. The acid-dissociation constants of 4-hydroxybenzothiazole and its derivatives were determined potentiometrically and spectrophotometrically, and the results were interpreted. The chelate-formation constants of the reagents with divalent metal ions were determined by the Calvin-Bjerrum potentiometric technique, and the results were discussed. The acid-dissociation constants as well as the chelate-formation constants were compared with the corresponding values of analogous compounds, primarily 8-quinolinol. This has provided useful information on some of the factors that influence the stability of metal chelates. Reactions between 4-hydroxybenzothiazole and its derivatives and metal ions were investigated. The lanthanon complexes with 4-hydroxybenzothiazole were prepared and characterized. An amperometric titration was worked out for the determination of 4-hydroxybenzothiazole as well as its metal chelates. (auth)

22280 (CEA-tr-R-1298) CHALEUR DE MELANGE DE L'EAU LEGERE ET DE L'EAU LOURDE. (Heat of Mixture of Light Water and Heavy Water). V. P. Skripov. Translated into French by B. Vinogradoff from Zhur. Eksptl'. i Teoret. Fiz., 35: 1294-5 (1958). 4p.

The heat of mixing H_2O and D_2O (99.7%) was measured in a rocking calorimeter at 24°C . During the mixing (up to a D molecular concentration of $n = 0.5$), a cooling of the sys-

tem was observed. The heat of mixing was measured as $q = 7.92 \pm 0.25$ cal/mole. The value calculated for the gaseous phase mixing was $q' = 34$ cal/mole. (J.S.R.)

22281 (UCRL-Trans-500(L)) MATERIALS ON THE STUDY OF CALCITE-WATER SYSTEMS. F. V. Syromyatnikov (Syromyatnikov). Translated by Esther S. Goldberg from Trudy Inst. Geol. Nauk, Akad. Nauk, S.S.S.R., p.221-9(n.d.). 12p.

The behavior of calcites in the presence of water is of great interest in geology. Experiments are described from which conclusions are drawn that water is chemically aggressive in relation to calcite. The formation of $\text{Ca}(\text{OH})_2$ and free CO_2 seem to result from the chemical reaction between calcite and water. It is stressed that any reaction of a solution with calcite, accompanied by its dissociation, can be cut off if the partial pressure of CO_2 reaches its threshold value. This depends on the character of the reaction, the temperature, the pressure, and the solution. Calcite without $\text{Ca}(\text{OH})_2$ can be stable in a liquid solution only in the presence of a sufficiently high partial pressure of CO_2 . (B.O.G.)

22282 ON THE POLYHALIDE IONS. R. E. Rundle (Ames Lab., Ames, Iowa). Acta Cryst., 14: 585-8(June 10, 1961). (IS-172). (In English)

Experimental evidence is cited to show that cation size is responsible for variation of the structure of the triiodide ion, I_3^- , and that in an isolated state the ion is probably linear and symmetrical with an over-all length, D , similar to the shortest distances found in crystals. The applicability of a simple molecular orbital description of the bonding without the use of outer d-orbitals is shown to be in keeping with most of the observed facts for polyhalides and polyhalogens. Where modification is necessary it is shown that a contribution of outer d-orbitals to σ -bonding, and to π -bonding can be added naturally to the MO description. These contributions can, in an MO description, be made large or small to minimize the energy of the system, and seem preferable to the valence bond, hybrid orbital description in its usual form since the latter description seems to require an arbitrarily high contribution of outer d-orbitals. (auth)

22283 THE HYDROGEN ISOTOPE EFFECT IN THE PYROLYSIS OF CYCLOPROPANE. Arthur T. Blades (Research Council of Alberta, Edmonton). Can. J. Chem., 39: 1401-7(July 1961).

The hydrogen isotope effect in the thermal rearrangement of cyclopropane was determined by the copolyolysis of cyclopropane and cyclopropane- d_4 . The isotope effect in the temperature range 407 to 514°C and at pressures of about 60 cm Hg may be expressed by $k_H/k_D = 0.82 \exp(1300/RT)$. The isotope effect is pressure dependent, decreasing from 1.98 at 76 cm Hg to 1.35 at 0.0178 cm Hg at 482°C. The isotope effect and its temperature and pressure dependence are discussed in relation to the mechanism. The conclusion is reached that though trimethylene may be formed as an intermediate, the isotope effect is consistent only with an activated complex where a hydrogen atom is weakly bonded both to its original and ultimate carbon atoms. A similar argument is presented to account for the previously described isotope effect in the decomposition of cyclobutane. (auth)

22284 METAL OXIDE ALKOXIDE POLYMERS. PART I. THE HYDROLYSIS OF SOME PRIMARY ALKOXIDES OF ZIRCONIUM. D. C. Bradley and D. G. Carter (Birkbeck Coll., London). Can. J. Chem., 39: 1434-43(July 1961).

Ebulliometric studies were made on the hydrolysis of some zirconium alkoxides, $\text{Zr}(\text{OR})_4$, where $\text{R} = \text{Et}$, Pr^n , Bu^i , and Bu^n . The variation of the degree of polymerization

of the zirconium oxide alkoxides produced was determined as a function of the degree of hydrolysis. The results are interpreted in terms of structural models based on octahedrally 6-co-ordinated zirconium. (auth)

22285 SORPTION OF RADIOACTIVE ISOTOPES ON PRECIPITATES. IV. SORPTION OF YTTRIUM ON IRON(III) HYDROXIDE. Z. Kolařík and V. Kouřim (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Collection Czechoslov. Chem. Commun., 26: 1082-91(Apr. 1961). (In German)

The reciprocal exchange of hydrogen and Y^{3+} ions on precipitates of Fe^{3+} was investigated radiometrically. Optimum conditions for the transport of yttrium from the solution to the precipitate and for the reverse process were found. The exchange equilibrium was interpreted with the help of the mass effect law. (tr-auth)

22286 VAPORIZATION OF IRIIDIUM AND RHODIUM. Morton B. Panish and Liane Reif (Avco Corp., Wilmington, Mass.). J. Chem. Phys., 34: 1915-18(June 1961).

The vaporization of iridium and rhodium was studied by Knudsen effusion and Langmuir evaporation techniques. The vapor pressure of iridium over the temperature range of 2100 to 2600°K is represented by the equation: $\log p_{\text{mm}} = 10.46 - (33980/T)$, and the vapor pressure of rhodium over the temperature range of 2050 to 2200°K by the equation: $\log p_{\text{mm}} = 10.28 - (28300/T)$. Third-law analyses of the data yield the following heats of vaporization: iridium, $\Delta H_{298} = 158.4 \pm 0.5$ kcal/mole; rhodium, $\Delta H_{298} = 132.8 \pm 0.3$ kcal/mole. Estimated boiling points for iridium and rhodium are 4800° and 3980°K, respectively. (auth)

22287 SHOCK TUBE DETERMINATION OF DISSOCIATION RATES OF OXYGEN. John P. Rink, Herbert T. Knight, and Russell E. Duff (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 34: 1942-7(June 1961).

The rate of dissociation of oxygen in $\text{Xe}-\text{O}_2$ mixtures was measured over a temperature range of 3000 to 6000°K. An x-ray densitometer was used to measure the density during the dissociation process behind a shock wave. It was possible to match the experimental data with theoretical density profiles over a wide range of compositions and initial conditions. The reactions considered were $\text{O}_2 + \text{M} \xrightleftharpoons[k_r]{k_d} 2 \text{O} + \text{M}$,

where M can be Xe, O_2 , or O. Considering these species as third bodies, the deduced recombination rates in $\text{cc}^2 \text{ mole}^{-2} \text{ sec}^{-1}$ were $4.7 \times 10^{17} \text{ T}^{-1}$, $1.6 \times 10^{18} \text{ T}^{-1}$, and $4.8 \times 10^{18} \text{ T}^{-1}$, respectively. The third-body efficiencies of O_2 and O relative to Xe are 3 and 10. An accurate measurement of the exponent of the temperature was not made. However, since the data showed it to be within the limits of $-1/2$ and -2 , a value of -1.0 was arbitrarily chosen. (auth)

22288 THEORY OF THE SURFACE TENSION OF MOLTEN SALTS. H. Reiss and S. W. Mayer (Atomics International, Canoga Park, Calif.). J. Chem. Phys., 34: 2001-3(June 1961).

The theory is based on a result obtained by Reiss, Frisch, Helfand, and Lebowitz and a theory of corresponding states. The theory allows one to compute the surface tension of a salt if the diameters of the ionic hard cores are known along with the densities of the salts at a given temperature. Agreement with experiment is very good. (auth)

22289 ELECTRICAL PROPERTIES OF ORGANIC SOLIDS. IV. CHARGE CARRIER DIFFUSIVITY IN METAL-FREE PHTHALOCYANINE. David R. Kearns and Melvin Calvin (Univ. of California, Berkeley). J. Chem. Phys., 34: 2022-5(June 1961).

The pulsed light technique was used to determine the

large carrier mobility in microcrystalline or amorphous, metal-free phthalocyanine layers. This appears to be of the order of 10^{-3} to 10^{-2} $\text{cm}^2 \text{sec}^{-1} \text{v}^{-1}$, and the positive holes are the majority carriers. The low values are attributed to the physical state of the layer. (auth)

2290 MAGNETIC PROPERTIES OF URANIUM TETRAFLUORIDE. M. J. M. Leask, Darrell W. Osborne, and P. Wolf (Oxford Univ.). *J. Chem. Phys.*, 34: 2090-9 (June 1961).

The magnetic susceptibility of a number of UF_4 samples as measured in the temperature range 1.3 to 20.4°K, using mutual inductance method. Although some of the samples were highly purified, initial measurements indicated appreciable differences between their susceptibilities below 2°K. These differences were eventually overcome by subjecting the specimens to the same heat treatment just before susceptibility measurement. The effect of the heat treatment is not entirely understood, but a number of possibilities were investigated. Theoretically, the main features of the susceptibility variation are explained on a simple crystal field model of noninteracting ions. An even better theoretical fit was obtained by introducing a small, adjustable interaction between neighboring uranium ions. Below 2°K the measured susceptibility was anomalous. Samples which at higher temperatures were very similar ($\pm 1\%$), showed considerable differences ($\sim 25\%$), the susceptibility in some cases increasing rapidly with decreasing temperature, and becoming dependent on measuring field. The behavior is unexplained but it is probably not a property of "pure" UF_4 . (auth)

2291 INTERACTION OF HYDROGEN AND NITROGEN WITH A MOLYBDENUM RIBBON. R. A. Pasternak and Hans D. Wiesendanger (Stanford Research Inst., Menlo Park, Calif.). *J. Chem. Phys.*, 34: 2062-8 (June 1961).

Adsorption and desorption studies, using flash-filament and ion gauge techniques, gave information on surface coverages, sticking probabilities, atom formation, and surface mobilities for the interaction of gases with a molybdenum ribbon. For hydrogen, saturation surface coverages were independent of pressure (10^{-8} – 10^{-6} mm Hg), within experimental errors, but depended strongly on temperature (225 to 500°K). Adsorption below 320°K proceeded in two steps. Two layers were successively adsorbed and completed at 120° and 225°K, respectively; each contained close to two hydrogen atoms per surface molybdenum atom. The sticking probability was 0.35; it remained constant during the formation of the first layer. At about 700°K, no measurable amounts of hydrogen were retained on the ribbon surface, but the kinetics of atom formation above 1200°K suggested that traces of hydrogen might be adsorbed at much higher temperatures. Finally, adsorbed hydrogen was readily replaced by other gases, such as nitrogen, even at room temperature. For the adsorption of nitrogen, the saturation surface coverage decreased only about 30% from 225 to 10°K; its value at room temperature was about one nitrogen atom per surface molybdenum atom. The initial sticking probability, in the same temperature range, decreased from 0.7 to 0.2. (auth)

2292 HEAT CAPACITY OF THULIUM FROM 15° TO 60°K. L. D. Jennings, Emma Hill, and F. H. Spedding (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 2082-9 (June 1961). (IS-177)

Thulium shows a λ anomaly in its heat capacity near 55°K which is associated with magnetic ordering and which shows thermal hysteresis. In addition, there are anomalous changes in the slope of the heat capacity curve near 88°, 162°, and 80°K. These changes and the unexpectedly low value of the

slope near room temperature complicate the analysis of the data, but there is evidence that the effective exchange integral in Tm is appreciably larger than that for neighboring rare earths. The results in the temperature range from 14 to 21°K support a T^3 dependence of the magnetic specific heat as predicted by spin wave theory for an antiferromagnet. The thermodynamic functions are tabulated for the temperature range studied. (auth)

2293 VAPORIZATION OF THE RARE EARTH OXIDES. Morton B. Panish (Avco Corp., Wilmington, Mass.). *J. Chem. Phys.*, 34: 2197-8 (June 1961). 1961).

The vaporization of Gd_2O_3 , Tb_2O_3 , Dy_2O_3 , Ho_2O_3 , Er_2O_3 , Tm_2O_3 , Yb_2O_3 , and Lu_2O_3 from 2000 to 2500°K was studied by analyzing the species effusing from an iridium effusion cell with a Bendix time-of-flight mass spectrometer. It appears that the rare earth sesquioxides may be divided into 2 groups, within each of which the vaporization mode changes from $\text{M}_2\text{O}_3 \rightarrow 2\text{MO}(\text{g}) + \text{O}(\text{g})$ to $\text{M}_2\text{O}_3 \rightarrow 2\text{M}(\text{g}) + 3\text{O}(\text{g})$ with increasing atomic number. (P.C.H.)

2294 MAXIMUM-OVERLAP DIRECTED-HYBRID ORBITALS. T. L. Gilbert and P. G. Lykos (Argonne National Lab., Ill.). *J. Chem. Phys.*, 34: 2199-2200 (June 1961).

A previous method for constructing best hybrid orbitals based on the principle of maximum overlap by Murrell is evaluated. A simpler and more general procedure is outlined. Use is made of the Carlson-Keller theorem which requires that positive roots be used and eliminates ambiguity. (P.C.H.)

2295 EFFECT OF PRESSURE ON THE SPECTRA OF MnO_4 AND CrO_4 . W. H. Bentley and H. G. Drickamer (Univ. of Illinois, Urbana). *J. Chem. Phys.*, 34: 2200 (June 1961).

The effect of pressure was measured on the intense allowed transitions in KMnO_4 and K_2CrO_4 in the solid state. Only the lower energy of the two large charge-transfer peaks was observed in each case. The KMnO_4 absorption showed considerable structure with 3 distinguishable peaks and several shoulders. A blue shift with increasing pressure was observed in both compounds. (P.C.H.)

2296 RUTHENIUM RED. J. M. Fletcher, B. F. Greenfield, C. J. Hardy, D. Scargill, and J. L. Woodhead (Atomic Energy Research Establishment, Harwell, Berks, Eng.). *J. Chem. Soc.*, 2000-6 (May 1961).

Experiments show that the ruthenium red cation is $[\text{Ru}_2\text{O}_2(\text{NH}_3)_{14}]^{8+}$ in which there are two oxo-bridges and the average oxidation number of ruthenium is $+10/3$. The cation is oxidized reversibly by a one-electron change to the more paramagnetic brown cation $[\text{Ru}_2\text{O}_2(\text{NH}_3)_{14}]^{7+}$. The relation to other polynuclear complexes is discussed. (auth)

2297 STUDIES ON THE CITRATE COMPLEX OF BERYLLIUM. Rabindra K. Patnaik and S. Pani (Univ. College of Engineering, Burla, Sambalpur, (Orissa), India). *J. Indian Chem. Soc.*, 38: 233-6 (Apr. 1961). (In English)

The complex was studied in the pH range of 2.6 to 6.0. Beryllium ions react with citric acid and form in the lower pH region a neutral complex (C) liberating two protons according to the reaction: $\text{Be}^{2+} + \text{H}_3\text{Cit} \rightleftharpoons \text{C} + 2\text{H}^+$. In the higher pH range (C) dissociates like a dibasic acid to complexes C_1^- and C_2^{2-} according to the reactions: $\text{C} \rightleftharpoons \text{C}_1^- + \text{H}^+$ and $\text{C}_1^- \rightleftharpoons \text{C}_2^{2-} + \text{H}^+$. The equilibrium constants of the reactions are 4.52×10^{-4} , 2.41×10^{-4} , and 4.95×10^{-6} , respectively. (auth)

2298 SOME THERMODYNAMIC PROPERTIES OF THE SYSTEM PLUTONIUM CHLORIDE-SODIUM CHLORIDE FROM ELECTROMOTIVE FORCE DATA. R. Benz and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). *J. Phys. Chem.*, 65: 1056-8 (June 1961).

A report is given on e.m.p. data as a function of temperature and composition obtained from galvanic cells of the type $\text{Pu}_{(\text{liq})}/\text{PuCl}_3 - \text{NaCl}_{(\text{liq})}/\text{Cl}_{2(\text{g})}$. The cell reaction is $\text{Pu}_{(\text{liq})} + \frac{3}{2} \text{Cl}_{2(\text{g})} = \text{PuCl}_{3(\text{liq}, \text{xl})}$. Thermodynamic formation quantities are derived. The standard free energy and entropy of formation of pure solid PuCl_3 were determined to be -170 kcal/mole and -52 eu, respectively. The PuCl_3 - NaCl system exhibits negative deviations from Rault's law. (P.C.H.)

22299 THERMAL DIFFUSION OF OXYGEN AND NITROGEN IN ZIRCONIUM. G. D. Rieck and H. A. C. M. Bruning (N. V. Philips Research Labs., Eindhoven, Netherlands). *Nature*, 190: 1181-2 (June 24, 1961).

Experiments were done to determine whether a diffusion of the Ludwig Soret-type occurred. It was concluded that when oxygen or nitrogen is dissolved in Zr a diffusion of this type occurs, causing the oxygen or nitrogen to move to the part of the metal which has the lower temperature. (P.C.H.)

22300 THE SOLUBILITY OF NICKEL IN SODIUM BY A TRACER TECHNIQUE. T. A. Kovacina and R. R. Miller (U. S. Naval Research Lab., Washington, D. C.). *Nuclear Sci. and Eng.*, 10: 163-6 (June 1961).

The solubility of nickel in liquid sodium of known purity under static near isothermal conditions was determined by a radioactive technique using Ni^{63} as the tracer. The solubility varied from 0.004 to 0.20 ppm over the temperature range 200 to 600°C. (auth)

22301 ENERGY-BAND STRUCTURE OF SOLIDS FROM A PERTURBATION ON THE "EMPTY LATTICE." F. Bassani (Argonne National Lab., Ill.) and V. Celli. *Phys. and Chem. Solids*, 20: 64-75 (June 1961). (In English)

A simple perturbation approach is developed to obtain the energy-band structure of solids. The unperturbed Hamiltonian consists of the kinetic part and of a uniform potential; the perturbing operator is the crystal potential plus a term which originates from the requirement that valence and conduction states be orthogonal to the inner states. This amounts to an approximation to the O.P.W. method. Reasons are given for the validity of such a simple scheme and applications are made to the case of the diamond lattice and of the zincblende lattice. It is shown how features of the energy-band structure depend on the symmetry of the lattice, on the lattice parameter, and on the "core states" of the atomic components. Numerical results obtained for diamond, silicon and BN are in fair agreement with recent calculations. An energy-band structure consistent with experimental information is obtained for Ge and GaAs by fixing the values of a few parameters. (auth)

22302 CURRENT-INDUCED MARKER MOTION IN GOLD WIRES. H. B. Huntington and A. R. Grone (Rensselaer Polytechnic Inst., Troy, N. Y.). *Phys. and Chem. Solids*, 20: 76-87 (June 1961). (In English)

The motion of light transverse scratches, used as markers, is observed on the surface of gold wires carrying current densities of about 10^4 amp/cm² for periods of several days. Clear evidence for a mass transport caused by momentum exchange with the electron current is shown by the magnitude and direction of the marker motion—several microns a day in some cases and always toward the cathode. This motion is exhibited by scratches on the central portion whose temperature varied from 850° to 1000°C. Water cooling maintained the ends of the wires near room temperature. In agreement with a simplified theory the marker motion appears to be proportional to the current density and the self-diffusion constant. Possible applications of this

technique include the indirect determination of the activation energy for diffusion and the investigation of the strength of interaction between the electrons and those lattice defects which constitute the activated complexes for atom jumping. In this case a value of 2μ ohm-cm/per cent was indicated for the "specific resistivity" of the diffusing atom in gold. (auth)

22303 CURRENT-INDUCED MARKER MOTION IN COPPER. A. R. Grone (Rensselaer Polytechnic Inst., Troy, N. Y.). *Phys. and Chem. Solids*, 20: 88-93 (June 1961). (In English)

Measurements of marker motion in copper were made from 785° to 1040°C. The technique resembled that used for previous experiments with gold. Temperature measurements were complicated by changing surface emissivity. Below 900°C markers moved toward the cathode with velocities/current densities approximately proportional to the self-diffusion coefficient, as might be expected for mass motion caused by momentum exchange with the current. Actual marker velocities were lower by approximately a factor of four than those observed in experiments with gold wires, owing to a fourfold decrease in the self-diffusion coefficient. In the temperature region below 900°C the "effective resistivity" of the activated complex appeared to be about 10^{-6} ohm m. At the higher temperatures the marker velocity goes through a maximum and finally changes sign near 1000°C. (auth)

22304 THE CRYSTALLINE STRUCTURE OF URANATES. II. URANATES CONTAINING URANYL-OXYGEN CHAINS. L. M. Kovba, G. P. Polunina, E. A. Ippolitova, Yu. P. Simanov, and V. I. Spitsyn (Moscow State Univ.). *Zhur. Fiz. Khim.*, 35: 719-22 (Apr. 1961). (In Russian)

The structures of α - Na_2UO_4 and β - CdUO_4 contain infinite chain octahedra of $(\text{UO}_2)_4$ joined by common edges. The sodium and cadmium atoms are in the center of several distorted octahedra, connecting the uranyl oxide chains together. (auth)

22305 METASTABLE HYDRIDE PHASE IN THE SYSTEM NIOBIUM-HYDROGEN. G. V. Samsonov and M. M. Antonova (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). *Zhur. Fiz. Khim.*, 35: 900-4 (Apr. 1961). (In Russian)

A metastable hydride phase forms on hydriding niobium powder at 600°. It has the structure of the β -niobium hydride (monohydride $\text{NbH}_{1.0}$) with a period decreasing with increasing hydrogen content up to a composition corresponding to $\text{NbH}_{1.34}$. It is assumed that the phase is metallic niobium, of which not all centers of the cubic lattice are filled with hydrogen, i. e., the random phase of the β -hydride. The basic kinetic parameters of niobium hydridation were established. The activation energy of the diffusional formation of the monohydride is equal to 3400 cal/mole. A more accurate value was obtained for the period of the pseudocubic lattice, equal to 3.42 kX. (auth)

22306 HEAT CAPACITY OF Ce_2O_3 AT HIGH TEMPERATURES. F. A. Kuznetsov and T. N. Rezhukhina (Moscow State Univ.). *Zhur. Fiz. Khim.*, 35: 956-7 (Apr. 1961). (In Russian)

The mean heat capacity of Ce_2O_3 (prepared by continuous reduction of 99.9% pure CeO_2 at 1150 to 1200°C) was measured. The mean molar heat capacity of Ce_2O_3 (molecular weight 328.26) is tabulated. The data are described with a precision of $\pm 0.5\%$, by the equation $\bar{C}_p = 25.17 + 6.327 \times 10^{-3} T$. (R.V.J.)

22307 THE HEAT CAPACITY OF Xe NEAR THE CRITICAL POINT AND THE VALUE OF $(\partial^2 p)/(\partial v^2)$. A. V.

Colonel. Zhur. Fiz. Khim., 35: 958-9 (Apr. 1961). (In Russian)

The heat capacity of Xe was measured at four densities $\rho = 1.14, 1.09, 0.98, \text{ and } 0.85 \text{ g/cm}^3$ near the critical point. The magnitude $(\partial^2 E / \partial V^2)_{T_c}$ evaluated with the data of H. V. Labgood et al., (Can. J. Chem. 32: 164, 1954) was $\approx 0.056 \text{ cal mol cm}^{-6}$. Measurements show $(\partial^3 p / \partial V^3)_{T_c} = -(3.7 \pm 0.7) \times 10^{-5} \text{ atm mole}^3 / \text{cm}^9$ per gas mole. (R.V.J.)

22308 COMPLEXING TETRAVALENT PLUTONIUM IN SULFURIC ACID SOLUTIONS. L. V. Lipis, B. F. Pozhar-kiĭ, and V. V. Fomin. Zhur. Strukt. Khim., 1: 417-24 (Nov.-Dec. 1960). (In Russian)

Complex plutonium ion formation in sulfuric acids proceeds by steps; at increased temperatures the stability of complex ions is reduced. Sulfate ion complexes of Pu^{4+} are expressed by the general formula $[\text{Pu}(\text{SO}_4)_n(\text{H}_2\text{O})_{8-n}]^{4-2n}$, where n has a value from 1 to 8. (R.V.J.)

22309 REACTION OF Ga, In, Tl, Ge, Sn, AND Pb WITH BORON. V. Samsonov, N. N. Zhuravlev, Yu. B. Paderno, O. I. Shulishova, and T. I. Sherebryakova (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Kiev). Zhur. Strukt. Khim., 1: 458-63 (Nov.-Dec. 1961). (In Russian)

Reactions of Ga, In, Ge, Sn, Tl, and Pb with B do not form chemical compounds or reciprocal solid solutions. The lack of any interaction between the III B and IV B subgroups and boron is explained by electron shell saturation and high ionization potentials. (tr-auth)

22310 NUCLEAR QUADRUPOLE RESONANCE IN CRYSTAL CHEMISTRY. E. I. Fedin and G. K. Semin (Inst. of Organic Compounds, Academy of Sciences, USSR). Zhur. Strukt. Khim., 1: 464-99 (Nov.-Dec. 1961). (In Russian)

Descriptions are given of nuclear quadrupole spectrometers, and aspects of nuclear quadrupole resonance applications are discussed. Attempts to determine electron density distribution in molecules, regularities binding chemical properties to nuclear quadrupole resonance, and efforts to determine real crystal structure are analyzed. Data are included on nuclear quadrupole resonance spectra for 477 chemical compounds. 161 references. (tr-auth)

22311 GIDRIDY PEREKHODNYKH METALLOV.

(Transition Metal Hydrides). V. I. Mikheeva. Moscow, Publishing House of the Academy of Science, 1960. 211p.

A detailed analysis is made of data on transition metal hydrides and their derivatives. The chemical properties of transition metal hydrides and their role in the systematics of inorganic compounds are studied. The reactions of lanthanides and actinides, titanium subgroups, and metals of groups V to VIII with hydrogen are analyzed. 678 references. (R.V.J.)

22312 KHIIMIYA URANA I TRANSURONOVYKH ELEMENTOV. (Chemistry of Uranium and Transuranic Elements). V. M. Vdovenko. Moscow-Leningrad, Publishing House of the Academy of Sciences, USSR, 1960. 700p.

Chemical and physico-chemical properties of uranium and transuranic elements and their compounds are discussed. Data are given on the chemistry of nuclear fuel and on problems of radiochemical separation and purification of transuranic elements from other fission products. Typical schemes for reprocessing irradiated fuel by precipitation, extraction, and ion exchange are analyzed. New methods based on anhydrous processes are also discussed. The book is designed as a handbook for chemists, engineers, and educators. 825 references. (R.V.J.)

22313 PREPARATION OF PLUTONIUM TRIFLUORIDE. Leland L. Burger and William E. Roake (to U. S.

Atomic Energy Commission). U. S. Patent 2,992,066. July 11, 1961.

A process of producing plutonium trifluoride by reacting dry plutonium(IV) oxalate with chlorofluorinated methane or ethane at 400 to 450°C and cooling the product in the absence of oxygen is described.

Radiation Chemistry and Radiochemistry

22314 (AD-249202) IRRADIATION OF PHENOLIC AND EPOXY RESIN MODEL COMPOUNDS. Quarterly Progress Report No. II, July 1-October 1, 1960 (Report No. 6).

Dale E. Van Sickle (Stanford Research Inst., Menlo Park, Calif.). Oct. 11, 1960. Contract DA-04-200-ORD-1056. 16p.

Investigations were carried out to determine the mode of degradation of phenolic resins subjected to beta or gamma irradiation, and, if possible, to compare this to proton irradiation in phenolic and epoxy compounds. Data are complete for the 4,4'-dihydroxydiphenylmethane irradiations and three runs were made on 2,4'-dihydroxydiphenylmethane. The 4,4' isomer appeared to be the most inert. This was apparent from both the low gas and polymer yields. In all cases more of the reactant was converted to high boilers than to volatile products. Alpha-phenyl cresols were the major volatile product from the dihydroxydiphenylmethane irradiations. Phenol was secondary in amount and cresols were present in the least amount. It was possible to study the radiolysis of saligenin, using an acetylating work-up procedure. Electron beam irradiation of linear phenol-formaldehyde polymers was unsatisfactory. (M.C.G.)

22315 (AD-251575) STUDY OF FACTORS INFLUENCING OXIDATION WHICH OCCUR IN IRRADIATED FATS.

Report No. 3 (Progress), January 1, 1960-June 30, 1960. W. O. Lundberg (Minnesota. Univ., Austin. Hormel Inst.). Contract DA-19-129-QM-1350. 8p.

The stability of fats was found to decrease proportional to the irradiation dose. Irradiation under oxygen is much more deleterious than under vacuum. The decrease in stability is largely caused by destruction of antioxidants but another effect is indicated by the stability decrease observed when pure methyl linoleate containing no antioxidant was irradiated. The stability of methyl linoleate irradiated under oxygen can be improved by addition of antioxidants after irradiation, and the stability of lard or corn oil irradiated under oxygen increases during postirradiation storage. (auth)

22316 (AD-251657) THE REACTIONS OF RECOIL TRITIUM ATOMS IN AQUEOUS SOLUTION. T. Kambara, R. Milford White, and F. S. Rowland (Kansas. Univ., Lawrence). Feb. 22, 1961. Contract AF19(604)-4053. 20p.

Tritium atoms recoiling from $\text{Li}^6(n,\alpha)\text{H}^3$ in aqueous solution form HT and HTO in the ratio of 0.10 ± 0.01 under most conditions. In concentrated $\text{Ca}(\text{NO}_3)_2$ solutions, the HT/HTO ratio decreases only to 0.023. The most important reaction leading to HT formation is the hot abstraction reaction $\text{T}^* + \text{H}_2\text{O} \rightarrow \text{HT} + \text{OH}$. (auth)

22317 (AFOSR-241) THE NATURE OF THE PRIMARY PROCESSES IN ELECTRON AND GAMMA IRRADIATED SYSTEMS. P. Y. Feng (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 21, 1961. Contract AF18(603)-121. 26p. (AD-251616).

A description is given of a study of the distribution of

the primary events in electron-irradiated systems as a function of electron energy. It is shown that, for systems of radiation chemical interest, i.e., with radiation energies in the kev to Mev region, approximately one-half of the absorbed energy is dissipated via secondary electrons with average energies less than ~60 ev and that variations in the effective spectrum of the electrons occur only in the higher energy region. Since the relative cross sections for the various electronic transitional events are much less sensitively energy dependent with high-energy electrons, the results of this model explains satisfactorily the known insensitivity of many primary radiation chemical processes on the initial-radiation energy spectrum. On the basis of this model, in a system irradiated by ~500 kev electrons, ~12% of the absorbed energy is dissipated via ~250 to 500 kev electrons, ~16% via ~25 to 250 kev electrons, ~9% via 2.5 to 25 kev electrons, ~17% via ~0.25 to 2.5 kev electrons, and ~46% via electrons less than ~250 ev, average less than ~60 ev, electrons. Such a distribution suggests the need of reconsidering some of the existing treatments on the nature of primary radiation chemical processes which were based only on the initial, or average, energy of the incoming radiations. (auth)

22318 (BNL-665) RADIATION PROCESSING. Report No. 3. GAMMA IRRADIATION OF GASEOUS CO₂. M. Steinberg (Brookhaven National Lab., Upton, N. Y.). Mar. 1961. 14p.

The Co⁶⁰ gamma irradiation of CO₂ over a range of pressure, temperature, and inhibitor concentration in a static system was investigated. For pure CO₂ gas at temperatures ranging from 26 to 538°C, at pressures from 22 to 68 atm, no formation of CO was detected. The addition of 2% NO₂ resulted in the formation of CO. For constant pressure-temperature conditions, and up to 2% CO concentration, the limits of this study, the yield of CO was proportional to the total dose and the G value remains constant. Decreasing the NO₂ concentration to 0.5% did not reduce the yield, and increasing the concentration to 5.0% NO₂ did not increase the CO yield. Increasing pressure produced a small negative effect; over the range of 4.3 atm to 68 atm, the G(CO) value decreased by about 11%. Increasing temperature affected the yield much more significantly. At 68 atm increasing the temperature from 26 to 270°C decreased the G(CO) value 2.5 times. Increasing the temperature to 538°C did not produce a further decrease in yield. The latter is interpreted on the basis of the mechanism whereby formation of NO causes an increase in the rate of the back reaction of CO and O. The average maximum G(CO) value obtained in this study was 4.5 which was slightly more than half that obtained in a heavy ion (alpha and fission fragment) radiation field. (auth)

22319 (Ls-89) THE SZILARD-CHALMERS EFFECT AND RELATED PROCESSES. A Bibliography. M. Gazith, comp. (Israel. Atomic Energy Commission, Tel-Aviv). Dec. 1960. 54p.

A bibliography is presented consisting of 226 references to the Szilard-Chalmers Effect and related processes, for the period 1934 to 1960. The sources of information include: Chemical Abstracts 1934 to 1960; Nuclear Science Abstracts 1948 to 1960; Journal of Inorganic and Nuclear Chemistry 1960; Proceedings of the Chemical Society (London) 1960; and The Journal of Chemical Physics 1960. CA and NSA references are included. (B.O.G.)

22320 (NARF-60-37T) THE EFFECTS OF REACTOR RADIATION ON ELASTOMERS AND SEALANTS. [PART III. L. L. Morgan (Convair, Fort Worth, Tex.). Apr. 28, 1961. Contract AF 33(600) 38946. 202p. (MR-N-174-3)

Fifteen types of liquid polymer polysulfide sealants and one crude polysulfide sealant were irradiated. Tensile specimens of each of the sealants were irradiated in air and fuel. Some peel specimens were irradiated. Irradiations were conducted to a maximum dose of 2.5×10^{10} ergs/gm(C) gamma and 1.5×10^{16} n/cm² (E > 0.33 Mev). The adhesion of sealants is not appreciably affected by radiation. The irradiations in fuel produced more damage than irradiations in air. (auth)

22321 (NP-10311) IRRADIATION "FACTOR-DEPENDENCY" STYRENE (MONOMER). Radiation Chemistry Laboratory Series Research Report No. 1. Edward F. Degering, Charles Merritt, Jr., Maurice Bazinet, G. J. Caldarella, M. Mancini, and E. F. Grey (Quartermaster Research and Engineering Center, Natick, Mass.). Nov. 1959. 38p.

A parametric study of radioinduced polymerization of styrene was carried out. Atmosphere, dose rate, and temperature were found to be statistically significant with respect to the amount of polymer obtained per unit of irradiation energy, with the dose rate being about twice as significant as atmosphere or temperature. With respect to molecular weights, temperature was found to be significant. Other significant parameters are discussed. (D.L.C.)

22322 (RIA-60-2562) POLYMERIZATION OF STYRENE AND BUTADIENE BY GAMMA RADIATION. Stanley L. Eisler (Rock Island Arsenal Lab., Ill.). Aug. 31, 1960. 14p. (PB-171041); (AD-251602)

Conversion rates of styrene and butadiene monomers to polymers, when exposed to gamma radiation, are reported, as are the molecular weights of the resultant polymers. It was found in each case that both the conversion rates and the molecular weights decrease as the dose rate increases. The irradiation of solutions of styrene in benzene provided similar results and in addition showed that concentration had no appreciable effect on conversion rate, but that a decrease in concentration produced a decrease in molecular weight. (auth)

22323 (NP-tr-519) ON THE SIGNIFICANCE OF COMPLEX COMPOUNDS IN RADIOCHEMISTRY. A. A. Grinberg. Translated from Zhur. Neorg. Khim., 3: 195-203 (1958). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract no. 13733.

22324 LIQUID SCINTILLATION COUNTING OF C¹⁴O₂ IN AQUEOUS CARBONATE SOLUTIONS. Jerry W. Harlan (Swift and Co. Research Labs., Chicago). Atomlight, No. 19, 8-11(June 1961).

A new method for C¹⁴O₂ assay was developed that is particularly useful in assaying expired CO₂ in animal metabolism studies. A novel feature of the method is the formation of a fine precipitate of Na₂CO₃ or NaHCO₃ in the counting vial when the scintillator is added. This permits the use of simple volumetric procedures and aqueous solutions. (P.C.H.)

22325 A SIMPLE REGULATORY MECHANISM FOR EVAPORATING LARGE LIQUID SAMPLES FOR RADIOACTIVITY MEASUREMENT. K. Haberer and P. Spindler (Technische Hochschule, Karlsruhe, Ger.). Atompraxis, 7: 206-8(June 1961). (In German)

A simple mechanism with which larger quantities of liquid can be automatically evaporated in relatively small vessels is described. The regulatory mechanism is based on the weight of the vessel, which exerts pressure, via a scales beam, on a flexible tube which is connected to the air inlet of a Mariotte flask, thus regulating liquid outflow. At the same time, the scales beam controls the surface

radiator via a mercury tumbler switch or a relay. The advantages of this method over others, including portionwise evaporation, are pointed out. (auth)

22326 RADIOLYSIS OF CRYSTALLINE OXALATO COMPLEXES. Akira Sugimori and Gen-ichi Tsuchihashi (Japan Atomic Energy Research Inst., Tokyo). *Bull. Chem. Soc. Japan*, 34: 449-50 (Mar. 1961). (In English)

Several crystalline metal oxalato complexes were irradiated with Co^{60} gamma rays. Oxalate ions such as in sodium oxalate and ferrous oxalate were found to be very stable to γ radiation, compared with those in metal oxalato complexes. Oxalate ions with large covalent character are decomposed more easily by γ radiation. The much larger G values of Fe^{3+} and Co^{3+} complexes than those of Al^{3+} are related to the reduction of metal ions. Chromium is stable in the Cr^{3+} and Cr^{6+} states but unstable as Cr^{2+} . (P.C.H.)

22327 RADIOIODINE EXCHANGE BETWEEN IODO-STEARIC ACID MONOLAYERS AND SUBSTRATE IODIDE. [PART] III. J. M. Ramaradhy and R. F. Robertson (McGill Univ., Montreal). *Can. J. Chem.*, 39: 1484-92 (July 1961).

Further studies were made of the isotopic exchange reaction between monolayers at the air/water interface of I^{131} - α -iodostearic acid and KI substrates. The dependence of the exchange velocity on substrate iodide ion concentration was examined by employing KCl-KI mixtures of constant over-all molarity to minimize possible variations in film characteristics with substrate salt concentration. The order in substrate I^- ion concentration was fractional at pH 2 and indeterminate at pH 3. The velocity of exchange at all KI concentrations was increased when KCl was added to the substrate. Surface potential measurements showed α -iodostearic acid to have a negative surface potential at high molecular areas which decreased to zero as the film was compressed. The apparent negativity of the surface potential increased as salt was added to the substrate. The surface potential varied with the substrate pH, passing through a maximum between pH 2 and 3. The isotopic exchange velocity and the surface potential were found to be closely related. The variation of the surface potential with time during isotopic exchange was examined both for monolayers and for collapsed films. (auth)

22328 AN UNIDENTIFIED I^{131} CONTAMINANT OF RADIOIODIDE PREPARATIONS. Alvin Taurog (Univ. of Texas, Dallas). *Endocrinology*, 69: 126-38 (July 1961).

A non-iodide I^{131} component was observed in a number of samples of radioiodide. This component, referred to as U, is biologically and chemically distinguishable from radioiodide. It resembles closely an I^{131} component previously encountered in subcellular preparations incubated with radioiodide. U, which appears to be an oxidized form of inorganic iodine, is acid labile and is not as well utilized by thyroid tissue as is radioiodide. Formation of U in radioiodide preparations can be prevented by the presence of reducing agents such as sulfite, cysteine, or 1 methyl-2-mercaptoimidazole. (auth)

22329 THE RADIOLYSIS OF WATER IN THE MODERATOR OF EXPERIMENTAL REACTORS. Henri Schmiid (Reaktor A. G., Wurenlingen, Switzerland and Brown, Boveri & Cie, Baden, Switzerland). *Inds. atomiques*, 5: No. 3-4, 94-102 (1961). (In French)

Moderator water is exposed to a flux of fast neutrons, slow neutrons, and gamma radiation. These radiations dissipate their energy in the moderator through ionization and excitation. The formation of free OD and D radicals result. These radicals either react with each other to reform water or to yield hydrogen peroxide and deuterium.

The hydrogen peroxide is unstable and releases O_2 and D_2 . In a very pure water where the free radicals do not participate in oxidation-reduction reactions, the inverse reactions $\text{OD} + \text{D}_2 \rightarrow \text{D}_2\text{O} + \text{D}$ and $\text{D} + \text{D}_2\text{O}_2 \rightarrow \text{D}_2\text{O} + \text{OD}$ occur. These reactions give an apparent stability to the water. Purification of the water permits a considerable reduction in moderator radiolysis. (several cc/kw-hr). (tr-auth)

22330 EFFECTS OF RADIATION ON CHEMICAL CONCENTRATIONS OF AQUEOUS SOLUTIONS. Catherine Vermeil (Institut du Radium, Paris). *Intern. J. Radiation Biol.*, 3: 307-26 (May 1961). (In French)

In the action of ionizing radiation on aqueous solutions, three zones of concentration may be distinguished: very dilute solutions, where all the phenomena associated with the indirect effect are observed; concentrated solutions, where the direct effect may be responsible for all the chemical changes of the solute; and an intermediate zone (medium concentrations) where the two effects may co-exist. The interpretation of results obtained at medium concentrations, which include the results for many biological systems, is often difficult. An attempt is made to clarify the concepts of direct and indirect effects and to find criteria by which the one may be distinguished from the other. Several pages are devoted to solute reactions in spurs, which intervene at medium concentrations. By examining experimental results obtained at medium and strong concentrations, it is shown that, although the radiation chemistry of dilute solutions may rest on a comparatively solid theoretical base, complementary hypotheses appear to be necessary in order to deal with more concentrated solutions. (auth)

22331 IONIZING RADIATION EFFECTS ON POLYMERS. Bretislav Dolezel (State Research Inst. for Protective Materials, Prague). *Jaderná energie*, 7: 151-7 (1961). (In Czech)

A survey of ionizing radiation effects on the properties of the most important polymers is given. The changes of chemical structure and physical properties of polyethylene, polyisobutylene, polystyrene, polytetrafluorethylene, polyvinylchloride, polyvinylalcohol, polymethylmethacrylate, polyamides, phenol-formaldehyde resins, melamine-formaldehyde resins, epoxy resins, and natural and synthetic rubber are described. (auth)

22332 POSITIVE AND NEGATIVE ION FORMATION IN CCl_3F . R. K. Curran (Westinghouse Research Labs., Pittsburgh). *J. Chem. Phys.*, 34: 2007-10 (June 1961).

A mass spectrometer with an ion source utilizing nearly monoenergetic electrons was used to measure appearance potentials of positive and negative ions in CCl_3F . Kinetic energy measurements were made on the negative ions. The results lead to values for the ionization potentials of CCl_3 , CCl_2F , and CClF . The C-F and C-Cl bond energies were determined from measurements on the negative fluorine and chlorine ions. A value is given for the electron affinity of the CCl_3 radical. (auth)

22333 EFFECT OF ELECTRON ENERGY ON SOME ELECTRON-IMPACT PROCESSES. Seymour Meyerson (American Oil Co., Whiting, Ind.). *J. Chem. Phys.*, 34: 2046-9 (June 1961).

Decomposition processes induced by electron impact were inferred from appearance potentials and from isotopic distributions of fragment ions in mass spectra of labeled compounds. Implicit in such inferences is an assumption that the paths by which the fragment ions are formed are the same near the appropriate appearance potentials as at the higher electron energies usually employed. For five ions that were the subjects of earlier studies— C_7H_7^+ from two

deuterated p-xylenes and $C_6H_5^+$ from two deuterated toluenes and a deuterated benzyl chloride—isotopic distribution was found to be essentially independent of electron energy. (auth)

22334 STUDY BY ELECTRON PARAMAGNETIC RESONANCE OF FORMALDEHYDE IRRADIATED IN THE SOLID STATE WITH γ , X, AND UV RAYS. Rose Marx and Claude Chachaty (Faculté des Sciences, Paris). *J. chim. phys.*, 58: 527-31 (May 1961). (In French)

The electron paramagnetic resonance spectrum of formaldehyde irradiated at 77°K by γ , x, and UV radiations appears to show the formation of the radical CHO^\cdot and of the polymer radical $-O-CH_2^\cdot$. The results obtained permit the explanation of some peculiarities of the polymerization of this monomer in the solid state. Under certain experimental conditions, a spectrum of short duration which could be attributed to the primary centers formed by the radiolysis of the formaldehyde was also observed. (tr-auth)

22335 γ -IRRADIATION OF LIQUID AND SOLID OXYGEN. Daniel W. Brown and Leo A. Wall (National Bureau of Standards, Washington, D. C.). *J. Phys. Chem.*, 65: 915-19 (June 1961).

Experiments were performed to determine the G-values for O_3 formation and also the variation in O_3 concentration in γ -irradiated liquid and solid oxygen as a function of radiation dosage, both when in the undiluted state and when mixed with Ar, N, or Kr. In undiluted oxygen both at 77 and at 90°K the average G-value observed was 6.0 ± 0.3 molecule/100 ev absorbed; at 4.2°K, it was about 4.6. From the G-values in mixtures it is inferred that significant energy transfer from diluents to oxygen occurs, but that the effect is obscured by kinetic complications when the diluent is Ar or Kr. The slope of the curve when ozone content is plotted as a function of radiation dose decreases by 35% in undiluted oxygen and by 45% in a 1:1 mixture of argon and oxygen between doses of 0 and 2.0×10^{22} e.v./g. at 77°K. The G-values for NO_2 formation in the mixtures containing nitrogen varied between 0.4 and 0.9 molecule/100 e.v. absorbed. (auth)

22336 THE PROTECTION EFFECT IN THE γ -RADIOLYSIS OF BENZENE-CYCLOHEXANE MIXTURES AND ITS EXPLANATION IN TERMS OF SELECTIVITY OF THE PRIMARY RADIATION ACT. J. Lamborn and A. J. Swallow (Imperial Coll. of Science and Tech., London). *J. Phys. Chem.*, 65: 920-2 (June 1961).

Polymer yields in γ -irradiated benzene-cyclohexane mixtures are lower than if the radiolysis of the two components proceeded independently. The results are explained in terms of preferential excitation of the π electrons of benzene by the fast electrons produced in the system. (auth)

22337 THE γ -RADIOLYSIS OF SOLUTIONS OF HYDROGEN CHLORIDE IN CYCLOHEXANE. P. J. Horner and A. J. Swallow (T. I. Research Labs., Cambridge, Eng. and Imperial Coll. of Science and Tech., London). *J. Phys. Chem.*, 65: 953-6 (June 1961).

Solutions of hydrogen chloride in cyclohexane, when irradiated with γ rays, give hydrogen with $G = 6.05$ compared with $G = 4.85$ from cyclohexane alone. When iodine is present (4×10^{-4} M) the yield for iodine removal is $G = 7.0$ atoms removed per 100 ev, compared with $G = 4.8$ in the absence of hydrogen chloride. Solutions of hydrogen chloride also differ from pure cyclohexane in that they become yellow on irradiation, and give cyclohexyl chloride and a highly unsaturated material of high molecular weight. No cyclohexene is produced. Many of these results can also be obtained with light instead of γ rays. It is concluded that excited molecules must be responsible for the effects. (auth)

22338 THE ROLE OF HYDROGEN ATOMS IN THE DECOMPOSITION OF HYDROGEN PEROXIDE AND IN THE RADIATION CHEMISTRY OF WATER. Gideon Czapski, Joshua Jortner, and Gabriel Stein (Hebrew Univ., Jerusalem). *J. Phys. Chem.*, 65: 964-6 (June 1961).

Atomic hydrogen generated by an electrodeless high frequency discharge in H_2 gas and introduced into aqueous solutions reacts with 10^{-4} to 10^{-6} M H_2O_2 with a velocity constant of $k \approx 10^5$ liter mole $^{-1}$ sec $^{-1}$, unaffected by changing the pH from 1 to 13. The reactions involved are discussed and compared with those postulated for the radiolysis of aqueous H_2O_2 solutions. (auth)

22339 GAS AND FREE RADICAL MEASUREMENTS IN IRRADIATED POLYVINYL CHLORIDE. B. R. Loy (Dow Chemical Company, Midland, Mich.). *J. Polymer Sci.*, 50: 245-52 (Mar. 1961).

Simultaneous gas and electron-spin resonance measurements of HCl evolution and free radical decay in irradiated PVC support Atchison's conclusion that three species of radicals are trapped. In accordance with first-order rates, each radical decays to yield a different but constant ratio of $[HCl]$ to $[R^\cdot]$ over its respective reaction period. Optical measurements indicate that each species yield a constant distribution of conjugated chain lengths. An explanation is offered whereby the dehydrochlorination process is restricted to isolated radical-pair systems. By this mechanism the average chain lengths are 26, 51, and 126 units for the short-, medium-, and long-lived radicals, respectively. (auth)

22340 EFFECT OF X-RAYS ON DYE SOLUTION. H. Matsuzawa, T. Nishino, K. Musha, S. Hayakawa, M. Akiyama, A. Hirahara, K. Ichikawa, and T. Hayashi (Gunma Univ., Japan). *Kitakankō Igaku*, 9: 568-75 (May 1959).

Dye solutions such as triphenyl-methane, azo, anthraquinone, cyanine, thilasin, and nitro groups were exposed to x rays. The color of the aqueous and chloroform solutions of these dyes faded or changed after the irradiation. The chloroform solutions were more sensitive than the aqueous solutions. This may be attributed to the indirect action of the Cl atom produced from chloroform. Cyanine and aminoazobenzene dyes which were very sensitive to irradiation may be of use for chemical determination of low radiation doses. (Abstr. Japan. Med., 1: No. 1, 1960)

22341 EFFECT OF X-IRRADIATION ON AN AQUEOUS SOLUTION OF $FeSO_4$. XIV. INDIRECT ACTION OF RADIATION. M. Matsui (Univ. of Hokkaido, Sapporo). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 753-8 (1959).

Radiation doses from 1000 to 100,000 r and concentrations of $FeSO_4$ from 1/100 to 1/100,000 M were studied. The oxidized product, Fe^{3+} , was measured with a spectrophotometer. In the range of concentrations investigated, the curve presenting the relationship between the ionic yield and the logarithm of concentration showed a sigmoid shape dilution effect. Only in the concentration range 1/1000 M was the degree of this effect proportional to the degree of dilution. The linear relation between the logarithm of O_2 concentrations in the solution and the ionic yield was found in the range of O_2 pressure from 10^{-3} to 10^{-2} mm Hg. The temperature of the solution during radiation appeared to have little influence upon the radiation effect. The production of Fe^{3+} ions may be the result of a photochemical reaction. (Abstr. Japan Med., 1: No. 2, 1960)

22342 MOLECULAR PRODUCT AND FREE RADICAL YIELDS IN THE DECOMPOSITION OF WATER BY PROTONS, DEUTERONS, AND HELIUM IONS. A. R. Anderson

and Edwin J. Hart (Argonne National Lab., Ill.). Radiation research, 14: 689-704 (June 1961).

With the formic acid-oxygen dosimeter (0.01 M formic acid, 0.001 N sulfuric acid, saturated with oxygen), molecular product, free radical, and water decomposition yields were measured for cyclotron-produced protons, deuterons, and helium ions, and 3.4 Mev α particles. Molecular product yields, $g(H_2)$ and $g(H_2O_2)$, increase, while the free radical yields, $g(OH)$ and $g(H)$, and the observable yield of water decomposition, $g(-H_2O)$, decrease with increasing LET of the incident radiation. However, if it is assumed that the recombination of radicals in the reaction $H + OH \rightarrow H_2O$ equals $g(H_2) + g(H_2O_2)$, then the total amount of water decomposing into free radicals, $g(-H_2O)_T = g(-H_2O) + g(H_2) + g(H_2O_2)$, is constant at 4.50 ± 0.13 for all cyclotron-produced particles used. The particles ranged in energy from 20.9 Mev (deuterons) having the lowest LET, to 8.35 Mev (helium ions) having the highest LET. The results are discussed in terms of the free radical model for cylindrical diffusion and are shown to agree well with the one-radical model calculations of Fricke and Flanders. The primary radiation yields, designated by the lower case $g(x)$, are obtained from the experimental yields, $G(H_2)$, $G(H_2O_2)$, $G(-O_2)$, and $G(CO_2)$ by the following series of equations applicable to the formic acid-oxygen dosimeter: $g(H_2) = G(H_2)$; $g(H_2O_2) = G(H_2O_2) - G(-O_2)$; $g(H) = 2G(-O_2) - G(CO_2)$; $g(OH) = G(CO_2)$. (auth)

22343 EFFECT OF GAMMA RADIATION ON CYCLO-HEPTAAMYLOSE. U. K. Misra, J. C. Picken, and Dexter French (Iowa State Univ., Ames). Radiation Research, 14: 775-8 (June 1961).

Cobalt-60 irradiation of cycloheptaamylose gives open-chain oligosaccharides in the chromatographic range maltotriose-maltoheptaose. Ring opening results in part from hydrolysis (to give maltoheptaose), but it is suggested that the principal reaction is local pyrolysis with destruction of one or more glucose units in the ring. (auth)

22344 DEPOSITION POTENTIAL OF ^{99}Tc FROM ALKALINE SOLUTION AND ITS APPLICATION TO STANDARD PURE β SOURCE ON THIN METALLIC FOIL. Niro Matsuura and Hiroshi Yumoto (Tokyo Univ.). Radioisotopes (Tokyo), 8: 28-33 (Mar. 1959). (In Japanese)

Joliot's cell is used to effect the deposition of low valence technetium on a silver foil of 0.005 mm thickness. With this cell and a G-M counter the beta radiation penetrating the foil during electrolysis can be measured. Hence the rate and completion of electrolysis can be determined. From plots of Tc deposition rate vs cathode potentials, a well defined critical potential for deposition from 2N NaOH is obtained near 0.75 v. The advantages and disadvantages of two different methods of deposition are also presented and discussed. (N.W.R.)

22345 ON THE ADSORPTION OF SEVERAL RADIO-NUCLIDES ON THE SURFACE OF CONTAINER MATERIALS. Nagao Ikeda and Jun Akaishi (Tokyo Univ. of Education and Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 8: 43-51 (Mar. 1959). (In Japanese)

The adsorption of several radioisotopes on container materials such as brass, galvanized iron, aluminum, copper, tin-plate, stainless steel, polyvinyl chloride, polyethylene, glass, porcelain tile, and paraffin was studied. Adsorption from tap water and sea water was measured using I^{131} , Sr^{90} - Y^{90} , Ce^{144} - Pr^{144} , Cs^{137} - Ba^{137m} , Zr^{95} - Nb^{95} , Ru^{106} - Rh^{106} , and gross fission products. Adsorption on the metallic surface was greater than on non-metallic. In the case of I^{131} , however, the vinyl sheet showed more adsorp-

tion than any of the others. A comparison of adsorption from tap water with that from sea water showed greater values for the latter. Adsorption of Y^{90} , Ce^{144} - Pr^{144} , Zr^{95} - Nb^{95} , or Ru^{106} - Rh^{106} is rather high, while Cs^{137} or Sr^{90} is lower. Other results showed that the adsorption value for polyethylene is not always smaller than glass, and in many cases glass proved to be the best container material. (N.W.R.)

22346 A BEHAVIOR OF RADIOACTIVE SCANDIUM TO THE CATION EXCHANGE RESIN. Kenjiro Kimura, Nagao Ikeda, Kan Kimura, Haruko Kawanishi, Mariko Kimura, and Ikuo Suzuki (Tokyo Univ.; Tokyo Univ. of Education; and Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 9: 108-11 (Sept. 1960). (In Japanese)

A tracer amount of Sc can be readily eluted from cation exchange resin with 0.5 to 5% oxalic acid solution. Other rare earth elements are not eluted. The K_d values for the elution of Sc at various concentrations of oxalic acid were determined. Elution curves for each concentration of oxalic acid were obtained by measuring radioactivities of the eluate at regular intervals with a G-M counter. From the elution curves the K_d values were calculated with the equation $K_d = (V-l)/M$. (P.C.H.)

22347 γ -RAY INDUCED DECOMPOSITION OF NITROGEN OXIDES. M. T. Dmitriev and L. V. Saradzhev (Inst. of Nitrogen Industry, USSR). Zhur. Fiz. Khim., 35: 727-35 (Apr. 1961). (In Russian)

The yield with respect to energy in the γ -induced decomposition of N_2O at 1 atm is 11.4 molecules of nitrous oxide per 100 ev and is independent of the ionization density. The product ratios are $[N_2] : [NO_2] : [O_2] = 1 : 0.48 : 0.14$. In the case of NO at 1 atm the yield is 14.8 nitric oxide molecules per 100 ev and depends to some extent upon the ionization density. The product ratios are: $[NO_2] : [N_2] : [N_2O] = 1 : 0.53 : 0.06$. In the case of NO_2 at 1 atm the yield is 2.1 nitrogen peroxide molecules per 100 ev and the product ratios, $[O_2] : [N_2O] : [N_2] = 1 : 0.33 : 0.25$. The probable mechanism of the radiation induced decomposition of nitrogen oxides is discussed. The principal part is played by excitation processes and decomposition of the excited molecules. Secondary processes are mainly interaction of excited molecules and nitrogen and oxygen atoms with the nitrogen oxides. The apparent resistance of pure nitrogen peroxide toward irradiation is due to the reverse reactions of NO_2 formation, which lowers considerably the energetic yield of the decomposition. (auth)

22348 REACTIONS OF SOLUTES IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. M. A. Proskurnin, V. D. Orekhov, and A. I. Chernova (Karpov Inst. of Physics and Chemistry, USSR). Zhur. Fiz. Khim., 35: 920-6 (Apr. 1961). (In Russian)

An equation was derived for the relation between conversion yield of radiolysis radical acceptor and its concentration in the solution. The derivation is based on the assumption of the existence of three types of active intermediates of radiolytic decomposition of water, possessing different reactivities toward the solutes. The concentration dependence of the yields based on experimental data obtained in studying a number of radiochemical processes is in agreement with the theoretical curves. It is shown that free radicals formed in the radiolysis of water do not exist in the free state, but immediately enter into complexes with dissolved substances. The complexes possess varying stabilities and decompose on collision with more efficient free radical acceptors. (auth)

22349 ACTION OF GAMMA-IRRADIATION ON DIMETHYL URACIL IN AQUEOUS SOLUTION IN ABSENCE

OF OXYGEN. G. Scholes, J. F. Ward, and J. J. Weiss (Univ. of Durham, Newcastle upon Tyne, Eng.). *Science*, 133: 2016-17 (June 23, 1961).

The action of ionizing radiations on dimethyl uracil in aqueous solution, in the absence of oxygen, was found to lead to the formation of the 4-dihydro, 5-hydroxy dimethyl uracil, shown to be identical with that formed by the action of ultraviolet radiation. In addition, the corresponding 4,5-glycol was also identified as one of the reaction products. (auth)

22350 METODY POLUCHENIYA I IZMERENIYA RADIOAKTIVNYKH PREPARATOV. (Methods of Preparations. A Symposium). V. V. Bochkarev, ed. Moscow, Atomizdat, 1960. 306p.

Sixteen papers are included on inorganic radioactive preparations such as carrier free isotopes, colloidal, and other medical preparations, and short-life industrial isotopes. In addition, 15 papers are devoted to methods for preparing labeled organic compound by synthesis and neutron irradiation of inactive compounds. Eight papers are devoted to absolute and relative activity measurements and radiometric analysis. Descriptions are given of new devices and instrumentations as well as of the measuring techniques. (R.V.J.)

22351 RADIOAKTIVNI IZOTOP IODA I^{131} . (Radioactive Isotope I^{131}). L. S. Kozyreva-Aleksandrova and N. I. Temnikova. Moscow, Atomizdat, 1960. 22p.

Chemical properties, preparation, and applications of I^{131} in medicine, biology, and radiochemistry are discussed. (R.V.J.)

Raw Materials and Feed Materials

22352 (CEA-1670) CRÉATION D'UNE INDUSTRIE DE L'OXYDE D'URANIUM DU LABORATOIRE A L'USINE PILOTE. (The Creation of a Uranium Oxide Industry, from the Laboratory Stage to a Pilot Plant). R. Caillat, M. Delange, R. Hauser, and J. Sauteron (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1961. 23p.

The physico-chemical features were studied of the phenomena accompanying the calcination of uranium peroxide or ammonium uranate to give uranium trioxide, and the subsequent reduction to dioxide as well as the sintering of the powders obtained. This work made it possible to prepare powder of known specific surface area, and to show the overriding influence of this factor, all other things being equal, on the behavior of powders during sintering in a hydrogen atmosphere. The work led to defining two methods for sintering stoichiometric uranium oxide of high density. The technological study of the preparation of the powder and its industrial production are carried out at the plant of Le Bouchet which produces at the moment powders of known characteristics suitable for sintering in hydrogen at 1650°C without prior grinding. The industrial sintering is carried out in a pilot plant having a capacity of 25 metric tons/year, which operated since May 1958. (auth)

22353 (JEN-30-DMa/I-5) TRATAMIENTO DE LOS MINERALES DE URANIO DE SIERRA ALBARRANA. (Treatment of Uranium Minerals from Sierro Albarrana). L. Gutierrez Jodra, A. Perez Lufia, and M. Perarnau (Spain. Junta de Energía Nuclear, Madrid). 1960. 17p.

Uranium recovery by hydrometallurgy from brannerite found in Hornachuelos (Cordoba) is described. Acid and alkaline leaching and sodium chloride roasting were studied, and acid leaching proved the most satisfactory. The pro-

cedures used, in addition to uranium dissolution by acid leaching, for the obtention of nuclear grade uranium are described. (auth)

22354 (K-1479) POROUS METAL FILTERS; APPLICATION TO FEED MATERIALS PRODUCTION. T. Shapiro and E. L. Halstead (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 15, 1961. Contract W-7405-eng-26. 25p.

Application of sintered porous metal filters to solid-gas systems in the ORGDP Feed Materials Plant resulted in improved operation of the systems in which they have been installed. Porous filter elements of 316 stainless steel and Inconel material were installed and have far exceeded the on-stream life of the filters which had previously been used in the reduction, fluorine and cleanup reactor systems. Results of their use in the hydrofluorination system were not favorable, but it is probable that the high corrosion rate experienced with Monel can be overcome by maintaining the element temperature above the dew point at all times. Savings of \$84,521, compared with the cost of the filters which they replaced were realized during the year ending December 31, 1960, not including the effect of increased production capacity, and the indirect savings resulting from improved operation of other components affected by filter performance. (auth)

22355 REDUCTION OF U_3O_8 TO U_3O_{8-x} IN MODE OF CRYSTALLOGRAPHIC OUT-OF-STEP. Ryoitiro Sato (Mitsubishi Metal Mining and Metallurgical Lab., Omiya City, Japan), Hidekazu Doi, Bumpei Ishii, and Hajime Uchikoshi. *Acta Cryst.*, 14: 763-71 (July 1961). (In English)

When a single crystal of orthorhombic U_3O_8 is heated in vacuo, its electron diffraction patterns exhibit an interesting sequence of changes. First, some of the diffraction spots suffer a splitting, and then the splitting becomes pronounced with the elevation of temperature. The reduction of U_3O_8 to U_3O_{8-x} underlying these pattern changes seems to proceed, until the lower composition limit of U_3O_8 phase in the $UO_2 - U_3O_8$ phase diagram is reached. An interpretation for these anomalous diffraction patterns is carried out on the basis of diffraction theory of out-of-step structure. The physical quantities involved in the interference function, made up for the present purpose, are determined by comparing implications of the resulting interference function with the patterns actually obtained. By this, the mode of out-of-step in this problem is revealed, together with its physical meaning. It is concluded that a particular manner of valency conversions of uranium ions takes place in the reduction of U_3O_8 to U_3O_{8-x} and that slight positional changes accompanying the valency conversions are responsible for the pattern changes. (auth)

22356 REDUCTION OF URANIUM TETRAFLUORIDE WITH MAGNESIUM-CALCIUM MIXTURE. K. Nishihara, Y. Kondo, and Y. Matsumura (Kyoto Univ.). *Atompraxis*, 7: 212-13 (June 1961). (In English)

Small-scale reduction is recommended in order to estimate the yield of U from UF_4 . It was found that the yield increases at higher furnace temperatures and with higher Ca to Mg ratios. Conditions for obtaining massive U above 90% in small production are given. The small-scale production of UF_4 can be carried out with good yield. (P.C.H.)

22357 FACTORIAL DESIGN IN THE STUDY OF ACID LEACHING OF PEGMATITIC URANIUM ORES. D. G. Fisher, R. G. McIntosh, R. L. Eager and A. B. VanCleave. (Univ. of Saskatchewan, Saskatoon, Can.). *Can. J. Chem. Eng.*, 39: 139-44 (June 1961).

Factorial design of leaching tests done on pegmatitic uranium ores is an efficient method of studying the effects

of changes in process variables, as the required information may be obtained with a minimum expenditure of effort. The results of a complete five factor, two level, factorially designed experiment in which an acid-cure technique was used are discussed. The data obtained in two, half replicate, five factor, two level, tests in which a percolation leach technique was used, establish base levels of variables for further economic study of uranium recovery from Higginson Lake pegmatites. (auth)

22358 LEACHING OF URANIUM ORES USING ALKALINE CARBONATES AND BICARBONATES AT ATMOSPHERIC PRESSURE. A. Thunæs, E. A. Brown, A. T. Rabbits, R. Simard, and H. J. Herbst (to U. S. Atomic Energy Commission). U. S. Patent 2,992,887. July 18, 1961. A method of leaching uranium ores containing sulfides is described. The method consists of adding a leach solution containing alkaline carbonate and alkaline bicarbonate to the ore to form a slurry, passing the slurry through a series of agitators, passing an oxygen containing gas through the slurry in the last agitator in the series, passing the same gas enriched with carbon dioxide formed by the decomposition of bicarbonates in the slurry through the penultimate agitator and in the same manner passing the same gas increasingly enriched with carbon dioxide through the other agitators in the series. The conditions of agitation is such that the extraction of the uranium content will be substantially complete before the slurry reaches the last agitator.

Separation Processes

22359 (CF-61-1-106) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C, PROGRESS REPORT FOR DECEMBER 1960 AND JANUARY 1961. K. B. Brown (Oak Ridge National Lab., Tenn.). June 2, 1961. 53p.

Test work was completed on development of a stripping method for the amine extraction (Amex) process which produces a concentrated uranyl nitrate solution for shipment to the refinery. The process involves treatment of the amine extract with calcium nitrate solution to convert the uranium in the solvent to a nitrate complex, stripping the uranium with water or dilute nitric acid, and recovery of nitrate from the solvent for recycle by contact with a lime slurry. In development of flowsheets for final cycle plutonium recovery by extraction with amines, the Pu(IV) extraction isotherms appear to be fitted usefully well by the expression $E_a = E_1 \frac{[M_{(amine)}]^{-4} [M_{(Pu)}]^2}{[M_{(amine)}]^{-4} [M_{(Pu)}]^2}$. With both Diamine 336 and triaurylamine, in several diluents, $E_1 \approx 500$ from 1.5 M HNO_3 , and ≈ 10000 from ~ 2 M HNO_3 and 1 M $NaNO_3$. Stable organic phases were obtained up to 15 g Pu/liter with TLA in Solvesso 100 and with Diamine 336 in 50% Solvesso 100 and 10% tridecanol. Several strong organic reductants showed promise in preliminary tests for stripping extracted plutonium from the amine solution. A tentative flowsheet has been developed for the separation of transplutoniums from fission product rare earths which were coextracted from irradiated plutonium. Group separation is by extraction with a tertiary amine from a concentrated lithium chloride, aluminum chloride solution. Single-stage separation factors of ~ 100 have been confirmed by a 7-stage batch countercurrent experiment. Extraction is increased by decreasing the size of the amine molecule. The type of diluent used has a large effect on extractability and some effect on group separation. A differential gamma counting method was developed for measuring very large separations between Am and Eu. Strontium is currently recovered from Purex 1WW at

Hanford by a series of precipitation-redissolution steps which ultimately yield a solution containing strontium along with appreciable quantities of contaminating elements such as calcium, iron, and lead. Recent studies were made of possibilities for separating strontium from this solution by additional precipitation-redissolution steps. It was found that 80% of the initial strontium was recovered using ammonia, Na_2CO_3 , NaOH, and Na_2CO_3 precipitations, in that order. Over-all separation factors were Sr/Ca ~ 225 ; Sr/Fe $\sim 8 \times 10^3$; Sr/Pb ~ 360 . The equilibrium between aqueous hydrogen ion in 4 M $NaNO_3$ and tenth molar D2EHPA- NaD_2EHP in benzene has been established over the range $10^{-1} \leq [H^+]_{aq} \leq 10^{-13}$. The extractant becomes 1% Na at $[H^+] = 6.2 \times 10^{-6}$, and 99% Na at $[H^+] = 1.0 \times 10^{-6}$. Strontium extraction coefficients vary with the aqueous acidity according to the expected inverse square relationship in some cases and with continuously varying power dependences in others. The first power dependence on NaD_2EHPA concentration is consistent with dimeric extractant. (auth)

22360 (IS-302) PYROMETALLURGICAL REPROCESSING OF THORIUM-URANIUM FUEL. P. Chiotti, P. F. Woerner, and S. J. S. Parry (Ames Lab., Ames, Iowa). [June 9, 1961]. 54p.

A pyrometallurgical procedure proposal is outlined for reprocessing Th- U^{233} fuel. Data indicate that in Th-U dissolution in Mg, Po precipitates with the U, and Ce remains in the Mg-rich solution. Yttrium and other light rare earths are expected to concentrate along with alkali and alkaline earth in the Mg-rich solution while Cr, Fe, Zr, Mo, and Nb should concentrate in the U-rich phase. Data indicate that many impurities may be separated in fused KCl-LiCl-Zn systems from U and Th. Data are given on the distribution of Fe, Mo, Nb, Cr, Y, Zr, Th, U, Pa, and cerium between the salt and zinc phases on oxidation or reduction. Data are also included on extraction of Y, Ce, Th, and Pa from Mg-Th solution by KCl-LiCl-MgCl solution. (J.R.D.)

22361 (JEN-27-DMA/I-3) EL EFECTO FINAL DE LA EXTRACCION EN EL SISTEMA NITRATO DE URANILO-ETER DIETILICO-AGUA. II. FAST CONTINUA ETEREA. (The End Effect of Extraction in the System Uranyl Nitrate-Diethyl Ether-Water. II. Continuous Ether Phase). A. Perez Luiffa, L. Gutierrez Jodra, and A. Rius Miro (Spain. Junta de Energia Nuclear, Madrid). 1960. 12p.

The solvent transfer of uranyl nitrate from diethyl ether to water was studied in a spray column using water as the dispersed phase and an extraction direction from ether to water. The column is 102 cm long and has a diameter of 4.7 cm. The entrances of the phases are 77 cm apart. The flow rates of both phases were used as variables and the concentration of the continuous phase was determined at different heights. The logarithm curves of the concentration of the continuous phase as a function of the distance to the interphase show the presence of a concentration drop in the entrance of the continuous phase. This depends on the flow rates of the phases. No effect in the entrance of the dispersed phase was found. (auth)

22362 (NAS-NS-3101) LIQUID-LIQUID EXTRACTION WITH HIGH-MOLECULAR-WEIGHT AMINES. Fletcher L. Moore (Oak Ridge National Lab.). Dec. 15, 1960. 114p.

"Nuclear Science Series" of the National Research Council. Committee on Nuclear Science.

A general review of the technique is given followed by a discussion of the principles involved, a survey of applications to various systems, and a collection of selected procedures associated with the technique which are reported in the literature. (J.R.D.)

22363 (NP-10302) PAPER CHROMATOGRAPHY OF INORGANIC IONS IN NITRATE MEDIA. III. SEPARATION OF CALCIUM STRONTIUM, BARIUM AND RADIUM. M. C. Levi and J. Danon (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). 1960. 10p. (Notas de Física, Vol. 4, No. 15).

It is noted that alkali earths associate with the nitrate ion forming complexes with various stabilities. The separation between Ca-Sr-Ba was investigated in nitrate media by chromatography. Separations between Ba and Ra were observed by tracer techniques. Resulting data are included. (J.R.D.)

22364 (ORNL-3019) AN OXYHYDROCHLORINATION PROCESS FOR PREPARING URANIUM-MOLYBDENUM REACTOR FUELS FOR SOLVENT EXTRACTION: LABORATORY DEVELOPMENT. T. A. Gens (Oak Ridge National Lab., Tenn.). Mar. 16, 1961. Contract W-7405-eng-26. 23p.

A flowsheet, based on laboratory-scale data, is presented for oxyhydrochlorination of 90% uranium-10% molybdenum alloy with 15% HCl in air at 400°C in 18 hr. Up to 90% of the molybdenum is volatilized during oxyhydrochlorination and another 3 to 6% is removed by a 2-hr treatment with pure hydrogen chloride at 400°C. Residual chloride is removed by a 4-hr treatment with moist air at 400°C, and the product uranium oxide is dissolved in 4M nitric acid to yield a stable solvent extraction feed solution of 1M uranium, 0.017M molybdenum, 175 ppm chloride, and 1.7M nitric acid. The stainless steel cladding of the original fuel would be removed mechanically and the core recanned in aluminum prior to transfer to the core processing facility. The aluminum can would be removed by hydrochlorination prior to core treatment. (auth)

22365 (ORNL-3023) CONSOLIDATED EDISON FUEL LOSSES ON EXPOSURE TO IRRADIATED AND AERATED SULFEX AND DAREX DECLADDING SOLUTIONS. T. A. Gens (Oak Ridge National Lab., Tenn.). May 2, 1961. Contract W-7405-eng-26. 17p.

Exposure of refluxing final Sulfex decladding solution, to air while contacting nonirradiated Consolidated Edison-type fuel pellets caused total uranium losses to increase from 0.06 to 0.08% at 1 hr and to increase nearly 0.01% per hour thereafter. Similar treatment of the final Darex solution caused total uranium losses to triple, from 0.25 to 0.90%, at 3 hr and increase 0.05% per hour thereafter. In contrast, losses caused by Co-60 radiations in the absence of air at a radiant power density of about 1 watt/liter were not large enough to measure accurately in refluxing final Darex solution, and were smaller than losses caused by aeration in refluxing final Sulfex solution. In refluxing initial Sulfex solution, aeration and irradiation caused uranium losses to increase over 10-fold, from 0.017 to 0.29%, and 5-fold, from 0.017 to 0.086%, respectively, at 3 hr. In refluxing initial Darex solution, aeration had a minor effect for the first 10 hr while irradiation caused uranium losses to double, from 0.15 to 0.30%. (auth)

22366 (PAN-299/VIII) SEPARATION OF RARE EARTHS ON ANION EXCHANGE RESINS. II. ANION EXCHANGE BEHAVIOUR OF THE RARE EARTH COMPLEXES WITH ETHYLENEDIAMINETETRAACETIC ACID. J. Minczewski and R. Dybczyński (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1961. 25p.

Anion exchange behavior of the lanthanides in the system containing strongly basic anion exchange resin Amberlite IRA-400 (H_2Y^{2-}) and aqueous solution of disodium ethylenediaminetetraacetate ($\text{Na}_2\text{H}_2\text{Y}$), was investigated. Distribu-

tion coefficients were found to increase in a regular way within the cerium group reaching maximum at europium, and then to decrease when going to higher atomic numbers. The charge of complex ions was shown to be -1 for all the lanthanides and yttrium. A possible explanation based on differences of hydration of complex ions is given to account for large differences of distribution coefficients in the lanthanide series. The possibility of achieving of efficient separations on relatively short columns is also demonstrated. (auth)

22367 (TID-12848) EQUILIBRIUM EXTRACTION CHARACTERISTICS OF ALKYL AMINES AND NUCLEAR FUELS METALS IN NITRATE SYSTEMS. Progress Report VIII for the Period October 1, 1960-March 31, 1961. Edward A. Mason and Richard E. Skaydahl (Massachusetts Inst. of Tech., Cambridge). May 1, 1961. For Oak Ridge National Lab. Contract W-7405-Eng-26, Subcontract No. 1327. 17p.

Completion of the physical facilities and equipment set-up was accomplished and the initial phases of the experimental work was conducted. The work included the differential titration of triauryl amine, determination of the standard curve for ruthenium on a DU spectrophotometer, partial preparation of the nitro complex of nitrosyl ruthenium. The scintillation counting set-up was also checked out with regard to its response to background as a function of voltage, gain, and discriminator setting. (auth)

22368 (TID-13057) RECOVERY OF FLUORINE FROM FEED PLANT VENT GASES. C. C. Littlefield (Carbide and Carbon Chemicals Co. K-25 Plant, Oak Ridge, Tenn.). May 26, 1955. Decl. June 19, 1961. 6p. (KLD-59(Pt.3))

Tests were conducted to determine the effect of inlet fluorine concentration and UF_4 excess on fluorine recovery from vent gases. Other investigations were conducted to determine the suitability of ash from the recovery unit as feed for the recovery towers and to determine optimum cooling coil placement. Design of a plant scale fluorine recovery unit was based on the investigation results. (J.R.D.)

22369 (CEA-tr-A-968) SEPARATION DU STRONTIUM 90 À PARTIR DE SOLUTIONS. (Separation of Strontium-90 Beginning with Solutions). K. H. Lieser and N. Hild. Translated into French from Naturwissenschaften, 46: No. 21, 599-7(1959). 5p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 3582.

22370 (CEA-tr-R-1340) COPRECIPITANTS ORGANIQUES. XIII. COPRECIPITATION DU PLUTONIUM QUADRIVALENT. (Organic Coprecipitants. XIII. Coprecipitation of Quadrivalent Plutonium). V. I. Kuznetsov (Kouznetsov) and T. G. Akimova. Translated into French from Radiokhimiya, 3: 357-63(1960). 25p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 21383.

22371 (NP-tr-632) THE CHEMICAL AND TECHNICAL PRINCIPLES OF THE (FUEL ELEMENT) REPROCESSING PLANT AT MOL (BELGIUM) AND ITS CONSTRUCTION. H. Götte. Translated by D. Hanley (U.K.A.E.A., Atomic Energy Research Establishment) from Atom u. Strom, 6: No. 12, 103-7(1960). 21p.

A description is given of the method of carrying out the individual tasks at Mol in the reprocessing plant for the separation of fissionable and fertile materials from each other and from fission products. (B.O.G.)

22372 SELECTIVE DISSOLUTION OF URANIUM FROM URANIUM-URANIUM OXIDE MIXTURES BY

BROMINE-ETHYL ACETATE. G. F. Brunzie, T. R. Johnson, and R. K. Steunenberg (Argonne National Lab., Ill.). *Anal. Chem.*, 33: 1005-6 (July 1961).

A method is described whereby uranium is separated from its oxides by selectively dissolving the uranium in a 4M solution of bromine in ethyl acetate. Acids produced in side reactions of bromine with the solvent are neutralized by magnesium oxide, permitting an extension of the dissolution period. (auth)

22373 ELUTRIATION OF RADIOACTIVE SUBSTANCES FROM ION-EXCHANGERS. F. Martinola and L. A. Wegner (Farbenfabriken Bayer AG). *Atompraxis*, 7: 223-8 (June 1961). (In German)

Tests on the elutriation of radioactive substances were carried out on a mix-bed exchanger made of Lewatit S 100 and Lewatit MN which was used for purifying the cooling water of a swimming-pool reactor. The tests were made after operation periods of 1½ and 3 years. A 10% solution of trilon BVT in a 5% sodium lixivium and 20% hydrochloric acid both proved to be effective solvents. By using them successively, the measured gamma activity of both exchanger samples could be elutriated up to 2% and 5% respectively of the original value. In small-scale tests with a little elutriant as possible, an elutriation of ca 90% was achieved with a liquid volume of 10 l/l of exchanger. Using the identification of some nuclides made elsewhere in the elutriant showed that the cation exchanger was loaded mainly with Ce and Cs, the anion exchanger with Cr, Ru, and Zr-Nb. Ce and Cs could be effectively removed from the cation exchanger, and Zr-Nb from the anion exchanger. After elutriation, an observation of the gamma spectra showed mainly Ru¹⁰³ on the anion exchanger. On the cation exchanger there was an unidentified nuclide with a gamma disintegration corresponding to an energy of 750 kev. (auth)

22374 DISTRIBUTION OF NEPTUNIUM BETWEEN DI-(ETHYL HEXYL)-PHOSPHORIC ACID AND MINERAL ACIDS. Eiko Nakamura (Japan Atomic Energy Research Inst., Tokyo). *Bull. Chem. Soc. Japan*, 34: 402-6 (Mar. 1961). (In English)

With special attention to the oxidation states of Np, the extraction behavior of neptunium IV, V, and VI in dilute HDEHP-HCl and HDEHP-HClO₄ systems was studied. The acid and solvent dependence of K_d values are given for the three states of Np and also for U⁴⁺, U⁶⁺, Pa, Th and Zr. (P.C.H.)

22375 STUDIES ON EXTRACTION OF POLONIUM (IV) BY HEXONE FROM ACID SOLUTION. Niro Matsuura, Akira Ouchi, and Masuo Kojima (Tokyo Univ.). *Bull. Chem. Soc. Japan*, 34: 411-16 (Mar. 1961). (In English)

The ionic state of Po⁴⁺ in HCl and H₂SO₄ solutions was studied by solvent extraction with hexone. A Po solution stored in 0.4 N HNO₃ is strongly hydrolyzed by aging. The low extraction coefficient caused by hydrolysis became higher by heating the Po solution in stronger HNO₃. Po stored in 6 N HNO₃ can be extracted with constant extraction coefficient, about 80%, through the acidity range 1 to 6 N, if the extraction is carried out without aging. Almost no Po⁴⁺ was extracted by hexone from H₂SO₄ solution. By applying the mass action law the probable form of Po⁴⁺ near 2 N HCl was Po(OH)₂Cl₂⁻ or PoO₂²⁺. (P.C.H.)

22376 EXTRACTION OF URANYL NITRATE BY MEANS OF MIXTURES OF METHYL ETHYL KETONE AND CARBON TETRACHLORIDE. V. I. Kuznetsov and V. Blekhta (Inst. of Geochemistry and Inorganic Chemistry, Academy of Sciences, Moscow). *Collection Czechoslov. Chem. Commun.*, 26: 1092-8 (Apr. 1961). (In Russian)

In the extraction of uranyl nitrate from saturated calcium nitrate solutions, a mixture of 64 vol % methyl ethyl ketone and 36 vol % carbon tetrachloride can be used in place of ethyl ether. This mixture is equivalent to the ethyl ether, but is much less inflammable. The experimental conditions and results are the same as for the utilization of ethyl ether. The determination of the uranium extracted was made by use of arsenazo reagent. (tr-auth)

22377 SOLVENT-EXTRACTION OF SEPTIVALENT RHENIUM. PART I. HETEROGENEOUS EQUILIBRIA IN THE SYSTEM, AQUEOUS NITRIC ACID-POTASSIUM PERRHENATE-TRIBUTYL PHOSPHATE. A. S. Kertes and A. Beck (Hebrew Univ., Jerusalem). *J. Chem. Soc.*, 1921-6 (May 1961).

The extraction of septivalent rhenium into tributyl phosphate from aqueous nitric acid is investigated as a function of solvent concentration in the organic, and nitric acid concentration in the aqueous phase, the rhenium concentration being kept constant. The method of continuous variations is applied to follow the formation of the extractable rhenium compound. The results revealed that perrhenic acid was the only extractable species. The solvent-dependencies are found to be of the direct fourth-power. The mass-action effect and the anti-synergic interaction between nitric and perrhenic acid are used to interpret the extraction mechanism involved. An attempt is made to calculate the formation constant of perrhenic acid tetrasolvate. (auth)

22378 SOLVENT-EXTRACTION OF SEPTIVALENT RHENIUM. PART II. HETEROGENEOUS EQUILIBRIA IN THE SYSTEM, AQUEOUS NITRIC ACID-POTASSIUM PERRHENATE-"TRI-SIO-OCTYLAMINE." A. S. Kertes and A. Beck (Hebrew Univ., Jerusalem). *J. Chem. Soc.*, 1926-30 (May 1961).

The distribution of rhenium in its highest oxidation state between aqueous nitric acid and tris-(2,2,4-trimethylpentyl)-amine is investigated. The variation in the rhenium molarity in the organic phase with nitric acid concentration shows that the rhenium species extracted is free perrhenic acid, HReO₄. Job's method of continuous variations indicated NR₃·HReO₄ as the species present in the organic phase. Some information on the similar distribution mechanisms for rhenium(VII) in this amine system and in that of Dowex-1, an anion-exchange resin, is also obtained. Evidence is presented which indicates that the affinity of the amine for ReO₄⁻ is higher than for NO₃⁻. (auth)

22379 REACTOR FUEL PROCESSING. Technical Progress Review, Vol. 4, No. 2. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Apr. 1961. 83p.

A discussion of the commercial aspects of fuel processing is presented in which industrial participation is outlined and gas centrifugal uranium isotope separation is examined. The incident involving the Redox multipurpose dissolver is discussed in some detail. Information on preparation for fuel processing is outlined and various process flowsheets are presented. In other sections, developments in fuel processing are outlined followed by sections on waste disposal and developments in production of U, Th, Pu, and their compounds. (J.R.D.)

22380 PURIFICATION OF PLUTONIUM USING A CERIUM PRECIPITATE AS A CARRIER FOR FISSION PRODUCTS. B. F. Faris and C. M. Olson (to U. S. Atomic Energy Commission). U. S. Patent 2,991,150. July 4, 1961.

Bismuth phosphate carrier precipitation processes are described for the separation of plutonium from fission products wherein in at least one step bismuth phosphate is precipitated in the presence of hexavalent plutonium thereby carrying a portion of the fission products from soluble plu-

tonium values. In this step, a cerium phosphate precipitate is formed in conjunction with the bismuth phosphate precipitate, thereby increasing the amount of fission products removed from solution.

22381 DISSOLUTION OF ZIRCONIUM AND ALLOYS THEREFOR. John L. Swanson (to U. S. Atomic Energy Commission). U. S. Patent 2,992,067. July 11, 1961.

The dissolution of zirconium cladding in a water solution of ammonium fluoride and ammonium nitrate is described. The method finds particular utility in processing spent fuel elements for nuclear reactors. The zirconium cladding is first dissolved in a water solution of ammonium fluoride and ammonium nitrate; insoluble uranium and plutonium fluorides formed by attack of the solvent on the fuel material of the fuel element are then separated from the solution, and the fuel material is dissolved in another solution.

22382 ION EXCHANGE ADSORPTION PROCESS FOR PLUTONIUM SEPARATION. G. E. Boyd, E. R. Russell, and M. D. Taylor (to U. S. Atomic Energy Commission). U. S. Patent 2,992,249. July 11, 1961.

Ion exchange processes for the separation of plutonium from fission products are described. In accordance with these processes an aqueous solution containing plutonium and fission products is contacted with a cation exchange resin under conditions favoring adsorption of plutonium and fission products on the resin. A portion of the fission product is then eluted with a solution containing 0.05 to 1% by weight of a carboxylic acid. Plutonium is next eluted with a solution containing 2 to 8 per cent by weight of the same carboxylic acid, and the remaining fission products on the resin are eluted with an aqueous solution containing over 10 per cent by weight of sodium bisulfate.

22383 METHOD FOR DISSOLVING ZIRCONIUM-URANIUM COMPOSITIONS. T. A. Gens (to U. S. Atomic Energy Commission). U. S. Patent 2,992,886. July 18, 1961.

A method is described for treating a zirconium-uranium composition to form a stable solution from which uranium and other values may be extracted by contacting the composition with at least a 4 molar aqueous solution of ammonium fluoride at a temperature of about 100°C, adding a peroxide, in incremental amounts, to the heated solution

throughout the period of dissolution until all of the uranium is converted to soluble uranyl salt, adding nitric acid to the resultant solution to form a solvent extraction feed solution to convert the uranyl salt to a solvent extractable state, and thereafter recovering the uranium and other desired values from the feed solution by solvent extraction.

22384 PROCESS OF TREATING OR FORMING AN INSOLUBLE PLUTONIUM PRECIPITATE IN THE PRESENCE OF AN ORGANIC ACTIVE AGENT. J. H. Balthis (to U. S. Atomic Energy Commission). U. S. Patent 2,992,888. July 18, 1961.

Carrier precipitation processes for the separation of plutonium from fission products are described. In a process in which an insoluble precipitate is formed in a solution containing plutonium and fission products under conditions whereby plutonium is carried by the precipitate, and the precipitate is then separated from the remaining solution, an organic surface active agent is added to the mixture of precipitate and solution prior to separation of the precipitate from the supernatant solution, thereby improving the degree of separation of the precipitate from the solution.

22385 METHOD FOR SEPARATING PLUTONIUM AND FISSION PRODUCTS EMPLOYING AN OXIDE AS A CARRIER FOR FISSION PRODUCTS. T. H. Davies (to U. S. Atomic Energy Commission). U. S. Patent 2,992,889. July 18, 1961.

Carrier precipitation processes for separating plutonium values from uranium fission products are described. Silicon dioxide or titanium dioxide in a finely divided state is added to an acidic aqueous solution containing hexavalent plutonium ions together with ions of uranium fission products. The supernatant solution containing plutonium ions is then separated from the oxide and the fission products associated therewith.

22386 PYROMETALLURGICAL METHOD. Paul A. Nelson (to U. S. Atomic Energy Commission). U. S. Patent 2,992,915. July 18, 1961.

The liquid-liquid extraction of plutonium by magnesium from uranium or uranium-chromium alloy is described. Calcium is added to magnesium in about eutectic proportions, which results in a purer plutonium.

ENGINEERING AND EQUIPMENT

General and Miscellaneous

22387 (ACNP-6105) REMOVAL OF ENTRAINED MOISTURE FROM STEAM USING NATURAL SEPARATION AND MECHANICAL DRYERS. Pathfinder Atomic Power Plant, Final Summary Report. J. F. Wilson and R. J. Grenda (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Apr. 15, 1961. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589.

Various types of natural-separation and mechanical dryers were tested for efficient removal of moisture droplets from steam. Primary separation of steam can be effected by natural separation and secondary separation by a mechanical dryer. A mesh-type mechanical dryer was selected for use in Pathfinder secondary separation. (D.L.C.)

22388 (BM-RI-5805) DEVELOPMENT OF A 10,000-AMPERE CELL FOR ELECTROREFINING TITANIUM. F. P. Haver (Bureau of Mines. Boulder City Metallurgy Research Lab., Nev.) and D. H. Baker (Bureau of Mines, Washington, D. C.). June 1960. 46p.

An electrolytic cell, developed for electrorefining Ti, produced premium-grade metal from very impure Kroll sponge at a processing cost of < \$0.60/lb. A cathode current density of 1000 amp/ft² and a molten NaCl electrolyte containing ~5 wt.% of soluble Ti were used, and the current efficiency averaged slightly less than 60%. (D.L.C.)

22389 (DP-566) RADIOCHEMICAL SEPARATIONS PLANT STUDY. PART II, DESIGN AND COST ESTIMATES. William H. Farrow, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Mar. 1961. Contract AT(07-2)-1. 239p.

Conceptual designs together with estimates of capital and operating costs were prepared for six radiochemical separations plants to process irradiated, nonproduction reactor fuels. The studies show the effect upon plant designs, capital, and operating costs of various maintenance techniques, plant capacities, and fuel element cladding materials. All cases studied presumed the use of mixer-settlers as the primary solvent extraction system contactor since data for this type of plant have not previously been available. Outlines are given of the general assumptions proposed by the AEC as the basis for the various cases to be studied. A review is included of the operating experience that led to the specific designs. Details of the data used in the preparation of the designs were included in appendixes to indicate the inherent complexity of plants of this type, the extent of the present study, and to afford the opportunity to adjust the designs and costs as necessary for other sites or process modifications. (auth)

22390 (HW-66715) AIR LIFT RECIRCULATION THROUGH UO₂ BEDS. F. D. Fisher (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1960. Contract AT(45-1)-1350. 39p.

A study was made of the behavior of gas-lift flows through packed beds of UO₂ particles. Gas-lift pumping provides recirculation of solvents through the dissolver barrels of a multibarrel dissolver suitable for use in the reprocessing of fuel elements containing slightly-enriched UO₂. Dissolver pressure drops, interactions between dissolver barrels, and the testing of simulated fuel-element loading canisters are discussed. (auth)

22391 (NAA-SR-Memo-5651) DESIGN OF A TEST SECTION FOR LOOP I. S. W. Gouse (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1960. 31p.

Results of a study are presented on aspects of the design, fabrication, and instrumentation of a test section for use in the organic moderated reactor program to study forced convection and sub-cooled boiling of Santowax R. (J.R.D.)

22392 (NP-10310) ELECTRICAL CONTACTS IN SPACE ENVIRONMENT. An Annotated Bibliography. George E. Owens, comp. (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). May 1961. 87p. (SB-61-23)

A survey is presented of recent literature pertaining to electrical contacts in a space environment. The references with abstracts are arranged alphabetically by personal author in three categories: books, reports, and journal articles. An index of secondary personal authors and corporate sources is provided, in addition to a subject index. (169 references.) (M.C.G.)

22393 (NYO-2578) ULTRASONIC PROMOTION OF FLOW IN THIXOTROPIC SYSTEMS. (Aeroprojects, Inc., West Chester, Penna.). Oct. 1960. Contract AT(30-1)-1836. 14p.

Ultrasonic activation has increased the flow rate of thixotropic gels through orifices and narrow channels. Thorium amalgam flow rates through a 0.052-in. orifice were sixteen fold greater than nonultrasonic controls. Alumina slips flowed at rates 300% greater when activated and it was possible to fill narrow channel molds with otherwise nonpourable formulations. (auth)

22394 (ORNL-3070) A REVIEW OF GLOVE BOX CONSTRUCTION AND EXPERIMENTATION. C. J. Barton (Oak Ridge National Lab., Tenn.). June 14, 1961. Contract W-7405-eng-26. 112p.

A series of fires and explosions in U. S. Atomic Energy Commission facilities handling α -active materials during the last five years resulted in reconsideration of safety problems associated with glove boxes and other equipment used to contain these materials. The literature on construction and operation of glove boxes for work with toxic inorganic materials not requiring biological shielding is reviewed as a contribution to this re-examination, with special emphasis on methods and equipment for working safely with plutonium and other α -active materials. An effort was made to point out the direction of current trends in this field. Detailed discussions of glove box designs and methods of experimentation in these enclosures are not included in this report but sufficient information is furnished for finding needed details in the referenced material. Methods for the detection and measurement of α -active materials and of impurities in controlled atmospheres are discussed. In addition, the literature on controlled atmosphere enclosures, glove boxes for non-toxic inorganic materials, and the technique of experimenting with such enclosures is reviewed. Some previously unpublished developments are reported. (auth)

22395 (RCC/R.119) A VERSATILE APPARATUS FOR THE HEATING AND EVAPORATION OF LIQUIDS IN SHIELDED BOX SYSTEMS. J. C. Charlton (United Kingdom Atomic Energy Authority. Research Group. Radiochemical Centre, Amersham, Bucks, England). Jan. 1961. 14p.

An apparatus developed for heating and evaporating liquids in shielded box systems consists of a vapor bath in which a 40 ml. centrifuge tube can be heated, together with a device for the removal of vapor from the centrifuge tube in a stream of air. Evaporation was rapid and trouble-free. The equipment can readily be handled remotely and is small enough to be "bagged-out" of the box. (auth)

22396 (TCEA-TM-12) LOW PRESSURE AERODYNAMIC FACILITIES. Proceedings of the Round Table Conference held in London (October 25-27, 1960). J. J. Smolderen, ed. (Training Center for Experimental Aerodynamics, Brussels). 150p.

Included in the discussions were aspects of instrumentation and pumping systems for low density aerodynamic facilities, low density facilities components, and research programs in low density aerodynamics. (J.R.D.)

22397 (UNM-TR-EE-51) MEASUREMENT OF LOW LEVEL MAGNETIC FIELDS UTILIZING THE HALL EFFECT. W. W. Grannemann and Jerrel R. Lochner (New Mexico Univ., Albuquerque. Engineering Experiment Station). Apr. 1961. For Sandia Corp. 94p. (SCDC-2341).

A method whereby varying magnetic fields of the order of 10^{-5} gauss may be measured is described. The Hall effect in semiconductors was used as the basis for the measurements. A theoretical investigation was made in regard to methods of improving the sensitivity of a Hall effect device with respect to the magnetic field. Increasing the sensitivity of the present Hall device may be accomplished in several ways. Reducing the thickness of the material and decreasing the carrier concentration will yield a combined increase in sensitivity by a factor of thirty. A gain in sensitivity of fifteen or more may be obtained by cooling the semiconductor. Equations were derived by which gains in sensitivity due to changes in different parameters of the Hall device may be calculated. Three major problems were encountered in the measurements of low level magnetic fields. Two problems were a direct result of the construction of the Hall device. An induced voltage and a residual voltage resulted from the placement of the Hall voltage leads and electrodes. The third problem was stray magnetic fields which tended to mask the desired signal at low levels. Situations were defined in which the problems demand attention or may be neglected. Compensating methods are given to reduce the effects of the induced voltage and residual voltage. With the use of a good Hall effect device and a very low noise transistor amplifier, magnetic fields of the order of 10^{-2} gauss may be measured. With the addition of a magnetic flux density concentrator the level of measurement can be lowered to 1.5×10^{-4} gauss. If a twin-T feedback filter amplifier is used to filter the desired signal from the stray magnetic signals, signals in the 10^{-5} gauss range can be measured. (auth)

22398 (WADD-TN-60-305) DESCRIPTION AND OPERATION OF A UNIVERSAL ADAPTOR FOR GENERAL MILLS AND MODEL 8 MANIPULATORS. Vincent L. J. Di Rito (Wright Air Development Div. Flight and Engineering Test Group, Wright-Patterson AFB, Ohio). Dec. 1960. 16p.

An investigation to develop a device which would permit interchangeable power tools for the Model 8 and General Mills manipulators is described. A universal adaptor was developed that can be attached permanently to the tools used in a hot cell. The design of the universal adaptor and the modifications to the manipulators needed to make them capable of receiving the adaptors are described. (auth)

22399 (WVT-RI-6002-I) STRENGTH AND ECONOMIC COMPARISON OF AUTOFRETTAGED VERSUS JACKETED PRESSURE VESSEL CONSTRUCTION. T. E. Davidson and D. P. Kendall (Watervliet Arsenal, N. Y.). Oct. 1960. 28p. (PB-171679)

The theoretical elastic strength of autofrettaged and jacketed thick-wall cylinders is presented in the form of equations and graphs. The mechanism by which both processes increase the elastic strength of a thick-wall cylinder is discussed and illustrated graphically. The advantages of a combination of jacketing and autofrettage for very thick-wall, pressure vessel applications are discussed and illustrated by a specific example. The economic advantages of autofrettage over jacketing are presented by a cost analysis of two specific examples, the 175mm Gun, T256 and the 155mm Howitzer T255. (auth)

22400 (AEC-tr-4547) THEORY OF NOTCH STRESSES: PRINCIPLES FOR EXACT CALCULATION OF STRENGTH WITH REFERENCE TO STRUCTURAL FORM AND MATERIAL. (Kerbspannungslehre: Grundlagen für genaue Festigkeitsberechnung mit Berücksichtigung, von Konstruktionsform und Werkstoff). Heinz Neuber. Translated from a publication of Springer-Verlag, Berlin, 1958). 293p.

The fundamental laws are stated for the control of the effect of structural form on the expected stress distribution and on the strength of the structural parts. Discussions are given of: basic concepts of the notch effect; fundamental principles of stress theory; theory of plane or two-dimensional notch effects; theory of spatial or three-dimensional notch effect; theory of prismatic notch effect; theory of load-relieving notches; theory of pointed notches; theory of flank angle; theory of the stress distribution in notches under non-linear stress-strain law; stress distribution with partial plasticizing; comparison of the theory with experimental and theoretical results of others; the influence of the notch effect on torsional rigidity; the stress concentration factor diagrams and their use; and final remarks and future prospects. An appendix includes a proof for the possibility that a deformation energy potential can exist in cases of non-linear stress-strain equations. An index is included of authors of the references used in the text. (B.O.G.)

22401 (NP-tr-636) WEAR OF CUTTING TOOLS (SELECTED PARTS). T. N. Loladze. Translation of "Iznos Rezhushchego Instrumenta" (A publication of State Publishing House of Scientific and Technical Literature on Machinery, Moscow, 1958). 159p.

The selections include the chapters concerned with: the nature of the contact of a cutting tool with a work material; the temperature in the contact layers; the structural transformations in contact layers during metal cutting; the theory of adhesion wear; the cutting of preheated steel at low speeds; the theory of chemical wear on hard alloys produced by powder metallurgical methods; and a discussion of the papers of Davil, Kazakov, and Trent on the subject of wearing of cutting tools. (B.O.G.)

22402 GAMMA-TESTING IN STEAM POWER STATIONS. W. Kolb. Atompraxis, 7: 146-50 (Apr. 1961). (In German)

A short review is given of the development of gamma testing in the construction of steam power stations. The problems arising in the construction of gamma-testing apparatus are then indicated. Examples of practical gamma tests in such stations are given. In conclusion, the danger of a too narrow interpretation of the regulations contained

the first radiation-protection ordinance are pointed out. (auth)

2403 PUMPS FOR WATER-COOLED POWER REACTORS. Nucleonics, 19: No. 7, 55-63 (July 1961).

Canned and limited leakage type pumps are compared in water cooled power reactor uses. For each type of pump, a discussion is given of the pumping capacity, auxiliary equipment requirements, repair needs, costs, and current and future developments. Operating experience with these pumps in various pressurized water, boiling water, and aqueous homogeneous type reactors is described. (T.F.H.)

2404 VALVES FOR WATER-COOLED REACTORS.

Ernest H. Gruenwald (Allis-Chalmers Mfg. Co., Milwaukee). Nucleonics, 19: No. 7, 64-9 (July 1961).

Various types of valves encountered in water cooled power reactors are studied with regard to nuclear requirements, reliability, functions, and improvement trends. Operating experience with these valves is discussed in pressurized water, boiling water, and aqueous homogeneous type reactors. (T.F.H.)

2405 HEAT EXCHANGERS FOR WATER-COOLED POWER REACTORS.

Georg T. Lewis, Jr., Michael Zizza, and Paul P. De Rienzo (Burns and Roe, Inc., Hempstead, N. Y.). Nucleonics, 19: No. 7, 70-80 (July 1961).

Main heat exchangers or steam generators in water cooled power reactors are discussed. Performance, maintenance, materials, fabrication, and cost optimization aspects of these systems are outlined. Special design features and efficiency considerations are described. A survey of the main heat exchangers in various pressurized water, boiling water, and aqueous homogeneous type reactors is presented. (T.F.H.)

2406 SOLVING DESIGN PROBLEMS FOR FOOD IRRADIATORS.

1. DOSE RATES FROM RECTANGULAR PLAQUES. Fred G. Moote (Curtiss-Wright Corp., Princeton, N. J.). 2. THREE-PLAQUE, TWO-PASS IRRADIATOR. John L. Donovan (Curtiss-Wright Corp., Princeton, N. J.). Nucleonics, 19: No. 7, 102; 104; 106; 108; 110 (July 1961).

Design and dose rate characteristics of rectangular plaque food irradiators are considered. Dose rate calculations are made for the rectangular plaques, under certain approximations, which agree with experiment within 5%. Using these calculations, a three-plaque Co^{60} irradiator is designed for 0.008 to 5 Mrad food irradiations. (T.F.H.)

2407 MAGNETOHYDRODYNAMIC GENERATOR WITH ROCKET ENGINE. Przegląd Tech., No. 45, 10 (1960).

The magnetohydrodynamic theory and operating principle of the "MHD" magnetohydrodynamic generator are presented. The first such generator was designed at the end of 1959. Energy of strongly ionized air, heated to 2700°C, was directly converted into electric energy, and within 5 seconds 1 kw was produced. On the basis of this positive result, it was planned to build a big "MHD" generator and have it driven by a small rocket engine. (OTS)

2408 ACID CUTTING AND ACID POLISHING OF COPPER CRYSTALS. F. W. Young, Jr. and T. R. Wilson (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 32: 59-62 (May 1961).

An acid saw and an acid polisher for cutting and polishing copper crystals are described. Evidence is presented that this type of cutting and polishing does not introduce dislocations into the crystals. Using these techniques, copper

crystals with a dislocation density of $5 \times 10^5/\text{cm}^2$ are prepared. (auth)

22409 SMEAR CAMERA TECHNIQUE FOR FREE-SURFACE VELOCITY MEASUREMENT. W. C. Davis and B. G. Craig (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 32: 579-81 (May 1961).

An optical technique that permits recording the position of a very small region of a surface as a function of time is described. The surface must reflect light specularly, the arrangement must allow some space in front of the surface, and the radius of curvature of the surface must be large compared with the distance over which the position is of interest. There are no other restrictions on the surfaces to which the technique may be applied. The apparent position of the image of an object reflected in the free surface to be studied is recorded with a moving-image smear camera, and velocity is obtained from the record of position as a function of time. This technique is used to measure velocities between 5×10^3 and 5×10^5 cm/sec in times as short as 3×10^{-8} sec. (auth)

22410 THE USE OF INTENSIFYING SCREENS FOR BETATRON RADIOSCOPY OF PRODUCTS HAVING DIFFERENT THICKNESSES. A. E. Buzynov (Inst. of Physics of Metals, Academy of Sciences, USSR). Zavodskaya Lab., 27: 167-8 (1961). (In Russian)

When the type of intensifying screen used in radiography is changed, the intensification coefficient must be known in order to be able to recalculate the exposure needed for obtaining the desired optical density on the film. The thickness variations of the materials studied are usually not taken into consideration, although the primary spectrum is changed by Compton scattering and secondary radiation. In order to determine the correlation between the intensification effect of the screens and the thickness variations of the specimens, a series of tests were made with photographic film sandwiched between CaWO_4 fluorescent screens and Pb, using a betatron with a limiting gamma energy of 22 Mev, comparing the results with data obtained with Pb screens alone. The following analytical correlation was obtained: $\log K = 0.975 - 0.1235 d$, where K is the dose ratio in roentgens for a given thickness needed for obtaining the same optical density with and without intensifying screens and d is the thickness of the steel specimen used. This change of intensifying action must be taken into consideration when screens and specimen density are changed. (TTT)

22411 USE OF GERMANIUM SINGLE CRYSTALS FOR OBTAINING MONOCHROMATIC X-RAYS. Yu. P. Simanov and V. K. Trunov (Moscow State Univ.). Zavodskaya Lab., 27: 180-1 (1961). (In Russian)

The excellent reflectivity of germanium with respect to x rays makes it possible to use it as a monochromator. A thin segment was cut out from a Ge single crystal parallel to the (111) plane, testing it with $K\alpha$ - Cu radiation generated at 30 kv and 10 milliamp in $1/2$ sec, using a 15-cm distance between the film and the crystals. Results showed that the Ge yields sharper and higher intensity lines than NaCl , CaF_2 , and CaCO_3 crystals. The absence of (222) is especially noteworthy. The Ge single crystal may be heated to 600 to 700°C without any noticeable plastic deformation. Layers with a radius of curvature of $R = 380$ mm have been prepared. This material has great potentialities as a monochromator. (TTT)

22412 FIRST INTERNATIONAL SYMPOSIUM ON GAS-LUBRICATED BEARINGS, OCTOBER 26-28, 1959, WASHINGTON, D. C. Dudley D. Fuller, ed. (Office of Naval Research, Washington, D. C.). 624p. (ACR-49)

The fluid mechanics, dynamics and instabilities, correlation between theory and experiment, philosophy, applications, and the method of treating the problems and obtaining a solution for gas-lubricated bearings are presented and discussed. There are twenty papers on these subjects. (N.W.R.)

22413 RADIOISOTOPE APPLICATIONS ENGINEERING. Jerome Kohl, René D. Zentner, and Herbert R. Lukens. Van Nostrand Nuclear Science Series. Princeton, N. J., D. Van Nostrand Company, Inc., 1961. 574p. \$16.50.

Basic useful material is provided on such topics as nuclear physics, shielding, legal and safety aspects, calculations for a tracer experiment, and the measurement of nuclear radiation. Radioisotope applications are discussed, including many references to work carried out abroad. Applications covered range from measuring flow, leakage, and concentration; determining friction and wear; radiography; and thickness and density gaging to radiation processing and process engineering applications. The appendix presents a legible version of the up-to-date General Electric Chart of Nuclides, reference sources of information on radioisotope applications, a compilation of useful constants and conversion factors including tables of e^x and factorials, and a very complete table of neutron activation products. (N.W.R.)

22414 SELF-CENTERING POSITIVE LOCKING GRAPNEL. Charles G. Hopper (to U. S. Atomic Energy Commission). U. S. Patent 2,991,112. July 4, 1961.

A grapnel used for remotely securing a load to be hoisted is described. The grapnel of the invention is generally conical in shape with a plurality of semi-open bores laterally disposed about the device. The bores meet at the apex of the grapnel and there provide a securing pocket for a spherical member. A load provided with a rigid support rod having a spherical member at its end can be secured by directing the spherical member down one of the bores and into the securing pocket. The major advantages of the invention reside in the self-centering and positive locking features.

22415 GAS SEAL. Harry Monson and Ernest Hutter (to U. S. Atomic Energy Commission). U. S. Patent 2,991,905. July 11, 1961.

A seal is described for a cover closing an opening in the top of a pressure vessel that may house a nuclear reactor. The seal comprises a U-shaped trough formed on the pressure vessel around the opening therein, a mass of metal in the trough, and an edge flange on the cover extending loosely into the trough and dipping into the metal mass. The lower portion of the metal mass is kept melted, and the upper portion, solid. The solid portion of the metal mass prevents pressure surges in the vessel from expelling the liquid portion of the metal mass from the trough; the liquid portion, thus held in place by the solid portion, does not allow gas to go through, and so gas cannot escape through shrinkage holes in the solid portion.

22416 TOOL ASSEMBLY WITH BI-DIRECTIONAL BEARING. G. E. Longhurst (to U. S. Atomic Energy Commission). U. S. Patent 2,992,048. July 11, 1961.

A two-direction motion bearing which is incorporated in a refueling nuclear fuel element transfer tool assembly is described. A plurality of bi-directional bearing assemblies are fixed equi-distantly about the circumference of the transfer tool assembly to provide the tool assembly with a bearing surface for both axial and rotational motion. Each bi-directional bearing assembly contains a plurality of circumferentially bulged rollers mounted in a unique arrangement which will provide a bearing surface for rotational movement of the tool assembly within a bore. The bi-directional

bearing assembly itself is capable of rotational motion and thus provides for longitudinal movement of the tool assembly.

22417 ELECTROSTATIC AIR CLEANING DEVICE AND METHOD. L. Silverman and D. M. Anderson (to U. S. Atomic Energy Commission). U. S. Patent 2,992,700. July 18, 1961.

A method and apparatus for utilizing friction-charged plastic spheres for removing by electrostatic means the particulate material from an aerosol are described. A bed of the plastic spheres is prepared, and the aerosol is passed upwardly through the bed at a rate just large enough to maintain the bed in a fluidized state with over-all circulation of the balls. Wire members criss-crossing through the bed rub against the balls and maintain their surfaces with electrostatic charges. The particulate material in the aerosol adheres to the surfaces of the balls.

Heat Transfer and Fluid Flow

22418 (AERE-M-867) THE SENSITIVITY OF A RESISTANCE BRIDGE FOR BURN-OUT DETECTION IN TWO-PHASE HEAT TRANSFER EXPERIMENTS. P. M. C. Lacey (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1961. 7p.

Incipient burn-out is frequently detected by using a Wheatstone bridge circuit in which two arms are provided by tappings from the heater element. An exact solution is presented for the sensitivity of the bridge when using an arbitrary fraction of the heater element, and an arbitrary bridge ratio. After applying simplifying approximations it is shown that the out-of-balance voltage appearing at the detector terminals is independent of the fraction of the heater element employed. An asymmetrical bridge has high sensitivity for a burn-out in the shorter arm but low for burn-out in the longer arm, and the center-tapped bridge has half the maximum possible sensitivity. Hence for ensuring protection of both ends of the heater the center-tapped full length bridge is recommended. (auth)

22419 (AFOSR-765) STABILITY AND TRANSITION OF THE FREE-CONVECTION LAYER ALONG A VERTICAL FLAT PLATE. Albin A. Szewczyk (Maryland. Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). May 1961. Contract AF49(638)-645. 88p. (BN-247)

The free-convection layer along a vertical flat plate was investigated theoretically as well as experimentally with a view to studying its instability and "natural" transition from laminar to turbulent flow. Stability calculations were carried out based upon the small perturbation theory for the exact velocity profile for the Prandtl number 10. Temperature profiles were measured along a vertical electrically-heated brass plate. By the use of a dye technique the natural transition mechanism was investigated, i.e., discrete vortex lines and their subsequent distortion into three-dimensional pattern and eventual breakdown was carefully studied. In addition a double-row vortex system, which arose in the free-convection layer, was investigated. Its mechanics and over-all effect on the stability and transition of the free-convection layer are discussed. (auth)

22420 (BMI-1517) BOILING-WATER VOID DISTRIBUTION AND SLIP RATIO IN HEATED CHANNELS. Final Report. James J. Foglia, Friedrich G. Peter, Harold M. Epstein, Roger O. Wooton, David A. Dingee, and Joel W. Chastain (Battelle Memorial Inst., Columbus, Ohio). May 31, 1961. Contract W-7405-eng-92. 36p.

Distribution of void and the behavior of slip ratio in light water in a rectangular heated test section were investigated with a beta-particle-attenuation technique. The amount of void in the subcooled region was determined to within $\pm 3\%$ void. Various combinations of the following conditions were investigated: pressures from 700 to 1300 psia, mass flow rates from 1.0 to 3.0×10^6 lb/hr/ft², and heat fluxes from 0.10 to 0.60×10^6 Btu/hr/ft². The test section was heated with both a-c and d-c power, and no significant difference in the results was detected. It was found that the slip ratio at a high Reynolds number is much more a function of the Reynolds number than of pressure. Furthermore, for Reynolds numbers between 50,000 and 90,000 the slip ratio at constant void fraction reaches a maximum. Some of the recent theoretical correlations of subcooled and bulk boiling were tested. The experimental bulk-boiling results compare reasonably well with the most recent theoretical models. Void fraction at zero quality can be correlated by the expression: $\alpha = 0.113 X_{ex} (L/L_B) / (P_c/P_{sat} - 1)$. (auth)

22421 (DEG-Report-203) A REVIEW OF DATA ON BURNOUT HEAT FLUX FOR STEAM-WATER MIXTURES IN UNIFORMLY HEATED CHANNELS. A. F. Pexton (United Kingdom Atomic Energy Authority, Development and Engineering Group, Risley, Lancs, England). Mar. 10, 1961. 32p.

A discussion is given of the available methods of predicting burnout heat flux in systems containing flowing mixtures of steam and water. The reliability of the methods when applied to experimental information obtained from uniformly heated round tubes, rectangular channels, and annular passages is reviewed, and the variables which influence two-phase burnout are considered with a view to explaining observed trends. It is concluded that a direct experimental study is required before confident prediction of burnout heat flux in divided fuel elements of the rod cluster type will become possible, and that sufficient information does not exist for general extrapolation of results obtained from simple geometries to such a case. Until further data become available it is suggested that a simple correlation, based only on the major variable, exit quality, should be used to calculate burnout heat flux in rod-cluster fuel elements cooled by steam-water mixtures at pressures of 1000 psia. (auth)

22422 (DP-562) HEAT TRANSFER BURNOUT OF A SURFACE CONTACTED BY A SPACER RIB. Samuel Mirshak and Robert H. Towell (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1961. Contract AT(07-2)-1. 22p.

Measurements showed that the burnout heat flux of surfaces locally insulated by vertical ribs and cooled by downward flowing water was as much as 32% lower than the burnout heat flux of surfaces without ribs. The results of the tests were correlated by an equation that includes the effects of the thermal conductivity and thickness of the heated surface, the width of the rib tip, and the clearance between the rib tip and the heated surface. (auth)

22423 (GEAP-3210) A BRIEF SURVEY OF THE LITERATURE PERTAINING TO FLOW PATTERN AND STABILITY CHARACTERISTICS OF VERTICAL UPWARD FLOWING BOILING WATER. Frank E. Tippetts (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 20, 1959. 22p.

A brief survey is presented on the published literature pertaining to the hydrodynamics of two-phase flow. The loop instability data reported support the hypothesis that transitions in flow patterns are the cause of local hydrodynamic instability, and it is suggested that the instability effects may be minimized by proper loop design. (D. L. C.)

22424 (NAA-SR-6328) ANALOG COMPUTER SIMULATION OF HEAT TRANSFER TO A MOVING FLUID. D. E. Fletchall (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 19, 1961. 32p.

Heat transfer equations for one-dimensional fluid flow through channels at constant velocities are solved for those cases in which the wall temperature is independent of length and those in which heat flux is independent of length. Transfer functions are derived for fluid outlet temperature to inlet temperature for these cases, outlet temperature to wall temperature for the first case, and outlet temperature to heat flux for the second case. Transfer functions for four types of analog computer approximations are compared with the theoretical transfer functions. The comparison indicates the analog model which best matches the theoretical solution and the range of frequency for which the model is valid for a given node length. (auth)

22425 (SC-4544(RR)) AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF STEADY AND UNSTEADY FLOW IN TUBING, WITH SPECIAL APPLICATION TO SIMULATED MISSILE PRESSURE-SENSING SYSTEMS. Arnold L. Ducoffe and Frank M. White, Jr. (Sandia Corp., Albuquerque, N. Mex.). May 1961. 76p.

An analytical and experimental investigation of the steady-state isothermal flow in constant-diameter tubing was conducted. The pressure drop across the system was determined experimentally as a function of the system geometry, line length, line diameter, and tubing-union diameter, for tube Reynolds numbers between 500 and 100,000. The results indicate that a pseudo friction factor can be defined in such a way that the theory produces adequate correlation with experiment at room temperature or at elevated temperatures for insulated systems. The results of the steady-state analysis are applied to a quasi-steady analysis of isothermal flow in simulated missile-sensing systems. Three types of transient pressure inputs, impulse, continuous, and shock, were generated for various system geometries comprised of constant-diameter tubes, with straight-through unions located at the tube extremities, connected to a sensing volume. The experimental results are adequately correlated by the empirical theory for the three types of input generated at room temperatures. (auth)

22426 (SCR-288) MACH TABLES FOR REAL GAS EQUILIBRIUM FLOW OF AIR IN HYPERVELOCITY TEST FACILITIES WITH TOTAL TEMPERATURES TO 10,000°K. K. L. Goin (Sandia Corp., Albuquerque, N. Mex.). Mar. 1961. 82p.

Aerodynamic flow parameters for isentropic expansions and flow through normal shocks, including real gas effects, have been calculated for total temperatures of 4000 to 10,000°K and for total pressures of 100 to 4000 atmospheres. Tables are presented in which flow parameters are listed for the throat of a nozzle and for Mach numbers at increments of 0.5 from 2.0 to 30.0. Flow parameters presented include the usual Mach number, velocity, pressure, temperature, and density relations plus other parameters useful in the analysis of real gas flows. Combinations of total pressure and temperature are such as to allow duplication of ambient atmospheric conditions at altitudes of 100,000 to 350,000 feet at flow velocities of 10,000 to 24,000 feet per second. (auth)

22427 (TID-12574) BASIC EXPERIMENTAL STUDIES ON BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES FOR MONTH OF MAY, 1961. Monthly Progress Report. Bruce Matzner (Columbia Univ., New York. Engineering Research Labs.). May 31, 1961. Contract AT(30-3)-187. 10p. (MPR-X-5-61)

Test operations with the unwrapped 7-rod test section were completed. The final run of the series was an intentional physical burnout. The results of operations for the spirally wrapped and the unwrapped 7-rod test sections are summarized. A single-rod test section, supplied to test the key features of a 19-rod test section, was received and is presently in operation. Fabrication work for the Columbia 19-rod test section is proceeding. The alterations to the previously unreliable joints around the top flange proved to be successful at currents as high as 12,700 amps during the operation of the unwrapped 7-rod test section. (auth)

22428 (TID-12983) PROGRESS REPORT FOR RESEARCH ON HEAT TRANSFER TO FLUIDS FLOWING THROUGH NON-CIRCULAR CHANNELS. Period covered: March 1961 to June 1961. E. R. G. Eckert and J. L. Novotny (Minnesota. Univ., [Minneapolis]. Heat Transfer Lab.). Contract AT(11-1)-659. 11p.

Experimental turbulent heat transfer studies were conducted in rectangular ducts with the boundary conditions of two heated and two unheated walls for an aspect ratio of 1:1 and Reynolds numbers of 10,000 to 100,000. The ducts have a thermal boundary condition of two vertical walls approximating an adiabatic boundary and two horizontal walls that approximate a constant heat flux boundary. The results are illustrated graphically as: centerline temperature for constant heat-flux walls; the heat transfer coefficient averaged in the circumferential direction over the heated walls as a function of the axial dimensionless distance; the fully developed Nusselt number based on the experimental heat transfer coefficient, the hydraulic diameter, and the thermal conductivity calculated from the average bulk as a function of the average Reynolds number for the duct. (B.O.G.)

22429 (NP-tr-623) ATOMIC ENERGY (SELECTED ARTICLES). Translated from Atomnaya Energ., 8: 367-70 (1960). 10p.

Included are two papers concerned with heat transfer to sodium at low Pe numbers, and separation of lithium isotopes in ordinary ion-exchange columns. Separate abstracts were prepared for each paper. (B.O.G.)

22430 (NP-tr-629) HEAT TRANSFER BY FORCED CONVECTION WITH TURBULENT FLOW, WHERE THE TEMPERATURE DIFFERENCE IS LARGE. Tomoshige Hara and Jun Okushi. Translated by R. A. Scutt (U.K.A.E.A. Atomic Energy Research Establishment) from Nippon Kikai Gakkai Rombun Shu, 24: 219-23 (Apr. 1958). 18p.

Heat transfer coefficients for circular cylinders in longitudinal turbulent air flows as measured by a cooling method are presented and the results are compared with those from previous work. Curves showing the relations between Reynold's number and Nusselt's number are included. (J.R.D.)

22431 (NP-tr-633) THE FLUIDISATION OF SOLID PARTICLES. K. Hirai, K. Fukaya, A. Shimada, and K. Mishima. Translated by L. Allen (U.K.A.E.A., Atomic Energy Research Establishment) from Kagaku Kogaku, 17: 438-47 (1953). 35p.

A general equation for the pressure drop in the flow of fluids through packed tubes was derived. The corresponding equations for the fluidization of solid particles are given. It was found that these equations are related to the expression for the terminal velocity of the fall of spheres in a gravitational field. In the fluidization of solid particles in air, two distinct phases can be observed, a dense phase and a dilute phase. Expressions were developed giving the extent of these phases, and, with their aid, it was possible to determine the height of the bed of fluidized particles. (auth)

22432 (NP-tr-646) STUDIES ON HEAT TRANSFER IN MULTISTAGE FLUIDISED BEDS. Iwao Muchi, Kiyoji Ozaki, Tatsurō Kagami, and Sakae Yagi. Translated by L. Allen (U.K.A.E.A. Atomic Energy Research Establishment) from Kagaku Kōgaku, 24: (2), 70-80 (1960). 40p.

A general model of a fluidized bed heat exchanger is considered in which the reaction heat is at an arbitrary level and in which there is heat loss from the tower walls. Changes are also considered to occur in the fluid temperature under non-steady conditions. Fundamental data relating to design of multistage fluidized bed reactor apparatuses and heat exchangers were obtained. (J.R.D.)

22433 (SCL-T-367) CONTRIBUTION TO THE THEORY OF THE AIR FOIL WITH FINITE AND ESPECIALLY SMALL WINGSPREAD. Excerpts. F. Weinig. Translated by Marcel I. Weinreich from Luftfahrt-Forsch., 13: 405-6 (Dec. 1936). 6p.

The lift diminution of an air foil (wing) with a small span as compared with the results of the conventional theory of the supporting line was calculated by comparing the former with an equivalent grid flow. This comparison of the calculated results with experimental outcome was satisfactory. (auth)

22434 THE TIME DEPENDENCE OF IRREVERSIBLE PROCESSES IN KNUDSEN GAS. G. Pataki. Acta Phys. Acad. Sci. Hung., 12: 311-19 (1960). (In Hungarian)

The time dependence of cross-effects (irreversible processes) in a Knudsen gas are discussed by means of two parameters of the conduction matrix. The reversal of sign of thermodynamic forces is examined and found, in contrast to Onsager's cross-effect, to be connected with the g/L matrix and not the L matrix, being off-diagonal. The reversal of sign of the forces does not occur with a stationary initial condition, while for a zero initial value of one of the forces the other generally reverses its sign. (auth)

22435 TEMPERATURE DISTRIBUTION ON COUETTE FLOW WITH RADIATION. R. Viskanta (Argonne National Lab., Ill.) and R. J. Grosh. ARS (Am. Rocket Soc.) J., 31: 839-40 (June 1961).

A Couette flow system is considered in which both conductive and radiative heat transfer occur. The energy equation for this type of system is a complicated nonlinear integro-differential equation. An approximation is applied to the radiant energy flux vector that is valid for intense absorption only. A comparison is made between temperature distributions obtained by the approximation and by evaluation of the exact integro-differential equation. (T.F.H.)

22436 FLOW RESISTANCE AND HEAT TRANSFER IN RING SLOTS WITH ROUGH NUCLEAR TUBES. [PART] II. H. Brauer (Mannesmann A. G., Duisburg, Ger.). Atomkernenergie, 6: 207-11 (May 1961). (In German)

Experimental results are compared with theoretical predictions. The practical application of test results is discussed. (J.S.R.)

22437 STUDIES OF HEAT REMOVAL BY GASES. E. Maillet, S. Francois, and M. Boutrails. Bull. inform. sci. et tech. (Paris), No. 50, 4-12 (Apr. 1961). (In French)

The extraction of energy from nuclear reactors by circulating gas requires careful thermal and aerodynamic experiments. The methods and means used by the Service of Mechanical and Thermal Studies at Saclay and examples of the results obtained are reviewed. (J.S.R.)

22438 THE THERMAL TRANSFER SECTION AT GRENOBLE. H. Mondin. Bull. inform. sci. et tech. (Paris), No. 50, 13-20 (Apr. 1961). (In French)

Heat removal by vaporization or by simple heating of water or organic liquids requires studies on the physics and mechanics of fluids in the particular fields of the double phase and of boundary layers at the walls, which must remain free from deposits. The aims and research means, especially experimental loops, at Grenoble are presented. (auth)

2439 STUDIES OF LIQUID METALS. L. Vautrey and J. Gollion. *Bull. inform. sci. et tech. (Paris)*, No. 50, 21-8 (Apr. 1961). (In French)

The use of liquid metals, such as sodium, for reactor cooling gives rise to a set of new problems of circulation, shielding, and obtention of high temperatures. The industrial-size installations at the Section of Liquid Metals or the study of thermal and mass transfer are described. (J.S.R.)

2440 HEAT TRANSFER TO HIGH-QUALITY STEAM-WATER MIXTURES FLOWING IN A HORIZONTAL RECTANGULAR DUCT. E. J. Davis (Gonzaga Univ., Spokane) and M. M. David. *Can. J. Chem. Eng.*, 39: 99-105 (June 1961).

Heat transfer and pressure drop were investigated for steam-water mixtures flowing in an electrically heated horizontal duct of rectangular cross section. The investigation was primarily concerned with the region of high vapor fractions and mass flow rates, where two-phase convection-controlled heat transfer predominated. The experimental data were found to be in good agreement with those of other studies in which circular tubes were used. The data in the convection-controlled region were correlated by equations developed from two flow models, a separated-annular model and a homogeneous model. Two phase pressure drop data were correlated satisfactorily by the Lockhart-Martinelli correlation. (auth)

2441 FLUID FRICTION AND HEAT TRANSFER IN CYLINDRICAL PIPES: RELATIONSHIP BETWEEN LUMPED AND DISTRIBUTED PARAMETERS. Julian C. Smith (Cornell Univ., Ithaca, N. Y.). *Can. J. Chem. Eng.*, 39: 106-12 (June 1961).

Physical phenomena may be described from the microscopic point of view, in terms of distributed parameters, or from the macroscopic viewpoint, using lumped parameters. Engineering correlations almost always involve lumped parameters. A lumped parameter is equal or proportional to some average value of the corresponding distributed parameter. Like any average quantity it gives no information regarding the form of the distribution. The use of lumped parameters therefore requires some assumptions, expressed or implied, regarding the form of the distribution within the system. The characteristic lumped parameters used in problems of heat transfer and fluid friction are over-all or average fluxes of heat energy or momentum. Common dimensionless groups, such as f , N_{Re} , N_{St} and others are ratios of these energy or momentum fluxes. Such dimensionless groups, since they are ratios of lumped parameters, are themselves lumped parameters. In their definition, therefore, several assumptions regarding the distributions of velocity and temperature are implicit. When these assumptions are not valid, correction factors such as diffusivity ratios or length-to-length ratios are needed to allow for deviations from the distributions used for reference. Using this approach the form of empirical equations becomes easy to predict. Dimensional analysis is not needed. In addition, this approach suggests that some accepted correlations may contain weaknesses not predicted by other methods. (auth)

22442 CRITICAL HEAT FLUX FOR WATER IN SWIRLING FLOW. R. Viskanta (Argonne National Lab., Ill.). *Nuclear Sci. and Eng.*, 10: 202-3 (June 1961).

A study of boiling burnout tests with water in swirling flow is reported. Critical heat fluxes were determined at a system pressure of 2000 psia. Isothermal pressure drop was measured, and nonboiling friction factors were calculated. Test results indicate that centrifugal forces are effective in breaking up the vapor film on the heated surface and increasing the critical heat flux in swirling flow. On the basis of constant pumping power, the critical heat fluxes obtained with swirl flow are a maximum of $2\frac{1}{2}$ times higher than those of straight flow. (P.C.H.)

22443 UNSTEADY FLOW OF A VISCOUS LIQUID CONTAINED BETWEEN TWO INFINITE CO-AXIAL CIRCULAR CYLINDERS. Ram Kumar (Univ. of Roorkee, India). *Proc. Natl. Inst. Sci. India. Pt. A*, 27: No. 1, 18-26 (Jan. 26, 1961).

The unsteady motion of a viscous liquid contained between two infinite co-axial cylinders in the presence of external forces is studied by means of a transform method. In particular, solutions are obtained when the external forces are caused by self-gravitating in the liquid or are of the form c/r . The frictional couples are also calculated in each case. (auth)

22444 HEAT TRANSFER MEANS. A. P. Fraas and G. F. Wislicenus (to U. S. Atomic Energy Commission). U. S. Patent 2,991,980. July 11, 1961.

A heat exchanger is adapted to uniformly cool a spherical surface. Equations for the design of a spherical heat exchanger having tubes with a uniform center-to-center spacing are given. The heat exchanger is illustrated in connection with a liquid-fueled reactor.

Instrumentation

22445 (AERE-R-3688) A THERMAL NEUTRON SCINTILLATION COUNTER FOR USE IN NEUTRON SCATTERING EXPERIMENTS. D. H. C. Harris (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1961. 17p.

Thermal-neutron scintillation counters of area 6 in. \times 3 in. were made using a mixture of zinc sulfide and a boron plastic enriched in boron-10. A study of suitable light guides was made and close fitting neutron shielding manufactured. The efficiency as a function of energy was determined and a comparison with lithium fluoride-zinc sulfide scintillators was made. (auth)

22446 (BNL-5391) CHARGE COLLECTION IN SEMICONDUCTOR PARTICLE DETECTORS. G. L. Miller (Brookhaven National Lab., Upton, N. Y.) and W. M. Gibson (Bell Telephone Labs., Inc., Murray Hill, N. J.). [1961]. 35p.

The mechanism of charge collection in semiconductor detectors is discussed. Loss of charge can be attributed to recombination of holes and electrons along the particle track or to trapping of the moving carriers. Experiments were made on a variety of silicon diodes, and a resistivity-collection efficiency correlation and a reduction of collection efficiency for heavily ionizing particles were observed. Trapping and recombination in homogeneous conductivity and surface barrier junction detectors were analyzed and the factors affecting carrier loss studied. (D.L.C.)

22447 (CERN-61-15) A NANOSECOND SAMPLING OSCILLOSCOPE. H. I. Pizer and H. Verweij (European

Organization for Nuclear Research, Geneva). May 16, 1961. 39p.

A sampling oscilloscope is described which can be used in conjunction with any slow oscilloscope. The rise time is shorter than 1 nsec. The sweep length can be continuously varied from 10^{-8} sec to 0 sec. The total range which can be scanned is 250 nsec. The scan-time can be varied in 8 steps from 1 sec to ≈ 7.5 msec. The maximum sensitivity is 50 mV/cm, with slow oscilloscope sensitivity of 50 mV/cm, and signals up to 8 V are displayed linearly, via the direct low impedance input. This input impedance was chosen to be 125 Ω , but other impedances are equally valid. A high impedance probe is available, giving a calibrated over-all attenuation of 2.7, 10, 100, or 1000. The maximum acceptable repetition rate of the input signal is 100 kc/s. The equivalent noise at the 125 Ω input is less than 10 mV. (auth)

22448 (CF-61-5-109) USE OF A STANDARD ORIFICE IN THE CALIBRATION OF VACUUM GAUGES. C. E. Normand (Oak Ridge National Lab., Tenn). May 4, 1961. 23p.

Investigations were conducted to determine the feasibility of using a standard orifice along with a metered gas leak to establish known pressures against which vacuum gages may be calibrated. A discussion of principles involved in the method is included along with experimental technique and results of gage calibrations. (J.R.D.)

22449 (CNEN-44) LO SPETTROMETRO A NEUTRONI POLARIZZATI DEL CENTRO DELLA CASACCIA DEL C.N.E.N. (The Polarized Neutrons Spectrometer of the "Centro di Studi Nucleari Della Casaccia.") E. de Agostino, F. Marsili, and A. Paoletti (Italy). Comitato Nazionale per L'Energia Nucleare, [Ispra]). Jan. 1961. 17p.

A description is given of the polarized neutron spectrometer built for operation at the TRIGA Mark II reactor of the "Centro di Studi Nucleari della Casaccia". The measured polarization of the thermal neutrons is better than 97% and the flipping efficiency is better than 96%. (auth)

22450 (CREL-977) AN ELECTRONIC DATA SCANNING AND DIGITIZING SYSTEM. C. G. Lennox and A. Pearson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Mar. 1961. 44p. (AECL-1232).

A program aimed at studying ways for effectively displaying reactor data is described. A signal scanning system operates at 2 kc/s and requires no d-c amplifiers. The system was designed to accept signals such as 0-100mv, 0-50 μ a, and 0-0.1 Ω/Ω . The digitizing accuracy is $\pm 1\%$ of full scale. A digital comparator identifies any signal exceeding a pre-set level. (auth)

22451 (DOFL-TR-931) REPRODUCE INSTRUMENTATION FOR PROJECT 6.2 OPERATION PLUMBBOB. J. C. Hoadley (Diamond Ordnance Fuze Labs., Washington, D. C.). May 1, 1961. 36p.

Instrumentation was developed for the reproduction of magnetic tape data recorded on Project 6.2 Operation Plumbbob, both for rapid field data readout and subsequent laboratory data analysis. Signals can be read out within ± 1 db over a frequency range from several cps to over 200 kc, with excellent fidelity. Previously available equipment was limited to a bandwidth of less than 100 kc. (auth)

22452 (NAA-SR-Memo-6128) TESTS OF THE HNPF PLUGGING METER. K. A. Davis (Atomics International, Div. of North American Aviation Inc., Canoga Park, Calif.). Feb. 13, 1961. 9p.

A plugging meter designed for the Hallam Nuclear Power Facility was tested. Plugging performance was satisfactory and excellent reproducibility was achieved. Although the time limitations precluded complete testing of the automatic control equipment, the tests performed gave satisfactory indication of correct performance. (auth)

22453 (NAA-SR-Memo-6254) FLEXIBLE FAST-SLOW PREAMPLIFIER FOR COINCIDENCE EXPERIMENTS. L. S. Beller (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 5, 1961. 24p.

A flexible fast-slow preamplifier unit, providing independent fast and slow linear signals, for use in U^{238} activation measurements is presented. The unit can be used in combined time-and-pulse-height measurements in the few-nanosecond region. Details of design, construction, adjustment, and performance are given. (auth)

22454 (NARF-61-18T) CALIBRATION OF FOILS FOR NEUTRON FLUX MEASUREMENTS. J. R. Bell and J. K. Miles (Convair, Fort Worth, Tex.). June 6, 1961. Contract AF 33(600) 38946. 116p. (MR-N-279)

A comprehensive foil calibration experiment was conducted. Irradiations were performed June 27 and 28, 1960, in the uniform fluxes of two different experimental facilities. The beta-counting efficiencies of end-window flow counters were determined for 25 types of foils. Gamma counter efficiencies were also determined for 10 types of foils. The absolute disintegration rate of each type foil was determined by one or more of the following methods: beta-gamma coincidence counting, 4π beta counting, or by relation to a similar foil of known disintegration rate. Neutron fluxes were measured in the wet-pool pneumatic tube and at one location in the irradiation cell. The analytical neutron spectrum of the Ground Test Reactor (GTR) in the pneumatic tube was verified. An intercalibration was performed in two ways: by determination of disintegration rates of calibrated gold, cobalt, and sulfur foils, and by determination of the fluxes from irradiated gold, cobalt, and sulfur foils. (auth)

22455 (NP-10257) FINAL REPORT ON FIELD OPERATION OF A HIGH SPEED STREAK SPECTROGRAPH. Gordon G. Milne and Thomas E. Putnam (Rochester, N. Y. Univ. Inst. of Optics). June 30, 1955. 5p.

Descriptions are given of the design, calibration, and characteristics of a high-speed streak spectrograph to be operated over the wavelength region of 3800 to 4800 Å. (B.O.G.)

22456 (NP-10327) THE EVOLUTION OF A HIGH FREQUENCY DYNAMIC PRESSURE MEASUREMENT AND ANALYTICAL SYSTEM FOR ROCKET AND NUCLEAR PROPULSION RESEARCH. F. F. Liu ([Quantum Dynamics, Tarzana, Calif.]). [1960?]. 50p.

Early developments in the evolution of a high-frequency dynamic pressure measurement and analytical system for rocket and nuclear propulsion research are reviewed. Cooling and heat transfer considerations for high-temperature operations in rocket engine measurement are discussed. The development of an instrumentation system with fast response capabilities by a combination of improvements in transducer and electronic techniques is outlined. The general design of a liquid-cooled pressure transducer which, while possessing superior transient response and heat transfer capabilities, would also not be affected adversely in its dynamic characteristics by high-temperature and water-cooled conditions is given. The water-cooled quartz transducers which resulted from this development work are based on the piezoelectric principal. The effects of radia-

on the transducers were investigated. The design concept of the wide-band Dyna-electrometer is described. To overcome the natural frequency limitations in the transducers, electronic compensation techniques were developed. Performance evaluations of the new system are reported. The effects of tubing and cavity on dynamic pressure measurement are discussed. The economics of the operation were assessed. A new high speed analog-to-digital dynamic data analytical system was developed. (M.C.G.)

2457 (SCTM-125-61(72)) PROPOSAL FOR A LOGICIZED MODULE SYSTEM. Joseph B. Rivard (Sandia Corp., Albuquerque, N. Mex.). Apr. 1961. 10p.

A system of interlocking modules and circuit boards applied to modular logic electronics for severe environments is proposed. Advantages of superior structural rigidity, lower manufacturing costs, and use of existing techniques are described. (auth)

2458 (SCTM-279-60(72)) A PRECISION, CONTINUOUS FLOW ENVIRONMENTAL APPARATUS DESIGNED FOR THE TESTING AND CALIBRATION OF HUMIDITY-MEASURING ELEMENTS. James B. Wade (Sandia Corp., Albuquerque, N. Mex.). Jan. 1961. 26p.

An apparatus is designed for testing and calibrating relative humidity elements. A brief history of other apparatus of this type and similar types is given along with the primary areas of differences. Factors affecting the design of the various parts, accuracy of the system, and its capabilities are discussed. (D.L.C.)

2459 (TID-3550(Rev.1)) NUCLEAR INSTRUMENTATION. A Literature Search. Henry D. Raleigh and Raymond L. Scott, comps. (Office of Technical Information Extension, AEC). May 1961. 153p.

This bibliography includes 1,728 references on the design, construction, and application of instruments for radioactive environments. Radiation detection instruments comprise the major portion of the references. Reports held by the Office of Technical Information Extension as of April 15, 1961, and references to journal articles which appear in *Nuclear Science Abstracts* are included. The references are arranged under the following headings: general, absorptimeters, air monitoring, amplifiers, betatron, bubble chambers, Cherenkov detectors, cloud chambers, coincidence counters, conferences, corrosion loops, dosimeters, electrostatic analyzers, fission chambers, Geiger counters, hot cells, in-pile loops, ionization chambers, liquid level gages, magnetic recording systems, nuclear emulsion analyzers, nuclear test aircraft, proportional counters, pulse analyzers, pulse generators, radiation detection instruments, radiochemical processing plants, radiological defense, radiological telemetering systems, reactors, remote-control equipment, scalars, scintillation detectors, spectrometers, and thickness gages. Within each category, the report references are arranged alpha-numerically by report number followed by an alphabetical listing of the journal references by title. (M.C.G.)

2460 (UCRL-6429-T) A LOW-BACKGROUND BETA COUNTER FOR USE IN ANTICOINCIDENCE WITH THE AMPEREX COSMIC RAY SHIELD. Jack H. Dellis (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 26, 1961. Contract W-7405-eng-48. 8p.

A description is given of the design characteristics of a low-background proportional counter operated in anticoincidence with an Amperex Cosmic Ray Counter, No. 18518. Emphasis of the design was placed on size, convenience of operation, and maintenance, as well as low-background. (B.O.G.)

24461 (UNM-TR-EE-52) STUDIES OF THE USE OF PHASE-LOCKED LOOPS IN ELECTRONIC DISTANCE MEASURING SYSTEMS. C. F. Chao, C. T. Hu, and A. H. Koschmann (New Mexico. Univ., Albuquerque. Engineering Experiment Station). [1961]. For Sandia Corp. 60p. (SCDC-2350)

Initial studies concerned with the extraction of information from a signal of the type $M(t) = A \sin[\omega_c t + \sum_{n=1}^N a_n \sin(\omega_n t + \phi_n(t))]$ where $\{\phi_n(t)\}$ represents the information are discussed. The principal method of detection studied is that using the phase-locked loop. Studies are also reported concerning a correlation type demodulation and on the general problem of double detection. (auth)

24462 (AEC-tr-4646) DETERMINING THE COEFFICIENT OF THERMAL CONDUCTIVITY OF CERAMIC MATERIALS. L. A. Plotnikov. Translated from *Zavodskaya Lab.*, 16: 1136-9(1950). 5p.

A method of determining the coefficient of thermal conductivity of ceramic materials by cooling the specimen rather than heating it is described. An alignment chart used to simplify the problem is presented. A test specimen is heated in a furnace and then allowed to cool in the surrounding air. When cooling begins, the temperatures of the center and surface of the specimen are measured at fixed intervals of time and the coefficient of thermal conductivity calculated. (M.C.G.)

24463 (AEC-tr-4638) METHOD OF MEASURING THERMAL CONDUCTIVITY OF SOLIDS. Pierre Vernotte. Translated from *Métaux (Corrosion-Inds.)*, 26: 216-17 (1951). 3p.

Presented at Refractory Materials Conference (A.E.R.A.), 1951.

Methods of measuring the thermal conductivity of both materials that are good conductors and insulating materials are described. The method of sustained signals for materials that are good conductors is described. The heat flow is obtained by knowing the specific heat and the changes of temperature with time. The essential modification to this method consisted of bringing to the end of a rod of the material, not a signal of an assigned form, but a periodical thermal phenomenon from which, to obtain a sinusoidal signal, the fundamental is extracted by experimentally finding the temperature low existing at a point already at a little distance, and calculating by empirical quadrature the two terms of the first order of the corresponding Fourier series. For insulating materials a touch-block method was set up. This method consists in applying to a plane surface of the insulating material under study a block of hot metal, protected by a guard device, and following, with a thermometer, the gradual cooling of the block. (M.C.G.)

24464 (CEA-tr-X-355) MESURE DES RAYONS β PAR L'EMPLOI DES COMPOSES ORGANIQUES FLUORESCENTS. I. MESURE DU SPECTRE DE β A L'AIDE DES MONOCRISTAUX D'ANTHRACENE. (Measurement of Beta Rays by Use of Fluorescent Organic Compounds. I. Measurement of β Spectra Using Anthracene Monocrystals). T. Watanabe. Translated into French from *Ôyô Butsuri*, 28: 377-80(1959). 12p.

It has been reported that the light pulse produced by monoenergetic electrons impinging on anthracene crystals is proportional to the electron energy within its limited range. In the present work, the response of a large single crystal of anthracene to impinging β rays emitted by radioactive substances is discussed. The crystal used is of cy-

lindrical shape, approximately 2.5 cm in diameter and 3.0 cm in height. It is glued with silicon grease to the photocathode of the Dumont 6292 photomultiplier tube. Output signals are proportionally amplified by an Al type linear amplifier and are analyzed by a single channel pulse analyzer. Beta spectra from pure β -emitting substances, such as S^{35} , RaD, RaE, RaF, or $Sr^{90} + Y^{90}$, are observed and compared with that obtained by a lens type magnetic β spectrometer with the result that the two spectra are similar except in the low energy part where the intensity of the former is higher. This seems attributable to both the β bremsstrahlung and the imperfection of the crystal which was colored and opaque. The relation between the maximum energy of the β rays and the pulse height is of good linearity from 0.16 to 2.2 Mev electron energy. (auth)

22465 (CEA-tr-X-378) SENSIBILITE PHOTOGRAPHIQUE AUX RAYONS γ DE L'EMULSION D'AZIDE D'ARGENT. (Photographic Sensitivity to γ Rays of Silver Azide Emulsions). N. Tomoda. Translated into French from Kogyo Kagaku Zasshi, 62: 1714-16(1959). 18p.

Emulsions prepared by the dispersion of silver azide in gelatin have some sensitivity to light. After its exposure to light, development in alkaline developer permits the obtaining of a negative. The photographic characteristics of this emulsion under the action of γ rays emitted by Co^{60} were studied. The effect of the nature of the gelatin and of the method of mixing the chemical products on the characteristics of the emulsion obtained was also examined. The test results showed that the addition of an organic acid in the emulsion increases its sensitivity. (tr-auth)

22466 (NP-tr-612(p.83-129)) THERMOCOUPLE FOR SHORT-DURATION TEMPERATURE MEASUREMENTS REACHING 2,300°. N. I. Svede-Shvets and M. V. Pridamtshev. Translated from p.619-35 of "Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovaniy, 1956," Moscow, 1959.

Studies were made of thermocouples for short-duration measurements reaching 2,300°. The difference of the potentials arising at the ends of an unevenly heated homogeneous conductor was used for temperature measurements. A thermocouple designed for short-duration measurements of liquid steel temperatures is described. Tungsten was used in the positive thermoelectrode and an alloy of molybdenum with aluminum was the negative. The thermocouple made it possible to measure temperatures in the 100 to 2,300°C range, developing during this a maximum thermal emf of the order of 20 mv. The smooth gain of its thermal emf as the temperature rose became linear in dependence on reaching 1,000°C. The thermocouple, after prolonged annealing of the molybdenum thermoelectrode, assures stable temperature measurements up to 2,000° in a vacuum and argon for more than 100 hours as well as those of short-duration. Numerous immersions of the non-renewable hot junction of the thermocouple into a liquid metal with the use of replaceable quartz caps did not cause a decrease in thermal emf. (M.C.G.)

22467 (NP-tr-648) THE ABSOLUTE MEASUREMENT OF THERMAL NEUTRON FLUX WITH GOLD FOILS. N. Mateescu. Translated by S.D. Mayer (U.K.A.E.A. Atomic Energy Research Establishment) from Acad. rep. populare Romine, Inst. fiz. atomica și Inst. fiz. Studii cercetări fiz., 11: No. 1, 83-96(1960). 37p. (Handwritten MS).

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 14, abstract no. 22641.

22468 (NP-tr-657) IMPULSE METHOD OF MEASURING THE SPECTRUM OF LIGHT IONS IN THE ATMOS-

HERE. L. R. Tsvang. Translated from *Izvest. Akad. Nauk S.S.S.R., Ser. Geofiz.*, No. 2, 202-9(1956). 13p. (FTS-9946/III)

A new method of measuring ion spectra in atmosphere, a theory of the method applied for flat cylindrical condensers, and a description of the apparatus designed for the method are given. (This paper was previously abstracted from the original language and appears in *NSA*, Vol. 10, abstract no. 9706.) (tr-auth)

22469 THE "RADIUS EFFECT" IN LARGE BF_3 COUNTER TUBES. J. Gordon and P. Szabó (Central Research Inst. for Physics, Budapest). *Acta Phys. Acad. Sci. Hung.*, 12: 333-4(1960). (In English)

A direct measurement was made of the radius effect in large-diameter (5 to 6 cm) BF_3 tubes. The number of counts per minute was measured as a function of the distance from the center of the hole in the Cd screen to the anode wire. The results showed that up to a distance of 20 mm from the anode wire the efficiency of these counters is virtually constant. (J.S.R.)

22470 REACTOR CORE TEMPERATURE MEASUREMENT. L. H. Shinault and T. F. McGrath (Rocketdyne Div., North American Aviation, Canoga Park, Calif.). *ARS (Am. Rocket Soc.) J.*, 31: 799-803(June 1961).

The design and development of a thermocouple suitable for the measurement of temperature in a nuclear reactor core are described. The thermocouple junction is formed by applying thin films of tungsten and rhenium on a ceramic rod and coating these films with a ceramic insulating film. The thermocouple is capable of operating over a temperature range of 100 to 5000°F and has a response time of 50 to 100 msec or less. Discussions of manufacturing methods and test results are presented. (auth)

22471 "PINHOLE CAMERA" FOR DETERMINATION OF PLASMA ARC ROTATIONAL SPEED. E. A. Bunt and H. L. Olson (Johns Hopkins Univ., Silver Spring, Md.). *ARS (Am. Rocket Soc.) J.*, 31: 826(June 1961).

The arc discharge column of a plasma jet is rotated in order to prevent melting of the electrodes. To determine the rotational speed of the arc, a phototube may be placed in such a position that once during each revolution the arc, jet pinhole, and phototube are aligned. The rotational speed may then be found from an oscillograph of the phototube current. (T.F.H.)

22472 DETERMINATION OF LIQUID SCINTILLATION COUNTING EFFICIENCY BY PULSE HEIGHT SHIFT. L. A. Baille (Sinclair Research Labs., Inc., Harvey, Ill.). *Atomlight*, No. 19, 1-7(June 1961).

A method was developed by which liquid scintillation counting efficiency can be determined simultaneously with the count. The two scalers of a liquid scintillation spectrometer are set to count simultaneously different parts of the spectrum. The ratio between the counts on the two scalers can be used as an accurate index of the counting efficiency on one of them. This method saves considerable time compared with the conventional internal standard method and appears to be of equal or greater accuracy. (auth)

22473 A PITFALL TO AVOID IN FERROUS SULPHATE DOSIMETRY. E. J. Hall and R. Oliver (Churchill Hospital, Oxford). *Brit. J. Radiol.*, 34: 397-8(June 1961).

Experiments on ferrous sulfate dosimeters showed an effect simulating a radiation exposure of approximately 5 rads/min as a result of leaving the solution in contact with a clear plastic container. It was concluded that the effect was due to interaction between the ferrous sulfate and the plasticiser used in the container. Results emphasize that

or chemical dosimetry it is always wise to carry out control experiments with unirradiated solutions. (C.H.)

22474 AN IMPROVED TWO-DIMENSIONAL SCANNER FOR RADIOCHROMATOGRAMS. Harold J. Perkins and J. Tyrrell (Canada Dept. of Agriculture, Research Station, Lethbridge, Alberta). *Can. J. Biochem. and Physiol.*, 39: 1183-8 (July 1961).

An improved scanner for two-dimensional radiochromatograms was designed. This scanner prints permanent facsimiles on electrosensitive paper in considerably less time than is required for conventional x-ray film autoradiography. The practical limit of detection is 35 cpm above background for C^{14} , although compact spots assaying as low as 20 cpm can be readily detected visually on the facsimile. (auth)

22475 THE APPLICATION OF β -RAY EXCITATION FLUORESCENCE TO THE MEASUREMENT OF THE THICKNESS OF DEPOSITS AND TO ANALYSIS. P. Martielli (Centre d'Etudes Nucléaires, Saclay, France) and G. Seibel. p.307-13 of "Colloquium Spectroscopicum Internationale VIII, 1959. (CEA-1945). (In French)

Principles of the method are outlined and the instrumentation used is described. The different types of radiation detectors were studied. As a source of β radiation $Sr^{90} + Y^{90}$ was used as well as Pm^{147} . Great care was taken to eliminate back-diffused electrons by deflection by a strong permanent magnet. The method was applied to the measurement of the thickness of deposits of Cr, Zn, Sn, Cd, and Cu on iron as well as Zn, Cr, Ag, and Au on copper and the results obtained are discussed. An attempt was made to use β -x-ray fluorescence for the analysis of minerals, monore, and glass, and for routine control of Si-Mn, Si-Ca, Fe-Mn, and Fe-W. Finally the method of β -x-ray fluorescence is compared with normal x-ray fluorescence and possibilities of further development are cited. (auth)

22476 BUBBLE CHAMBERS. R. Budde and J. Tremblay (CERN, Geneva). *Inds. atomiques*, 5: No. 3-4, 71-82 (1961). (In French)

The principles of operation and the theory of bubble chamber are reviewed. The physical properties and functional conditions of the liquids used in these chambers are discussed and tabulated. Then the construction and operation are considered, and examples of photographs obtained are given. (J.S.R.)

22477 THE MEASUREMENT OF THE RADIOACTIVE CONTAMINATION LEVELS IN DRINKING WATER. A. D. Wright (Elliott Nucleonics Ltd.). *Inds. atomiques*, 5: No. 3-4, 132-4 (1961). (In French)

A method for measuring water contamination is described. The method offers the double advantage of concentrating the solid elements in the water and of using a fixed sampling. The apparatus used is sketched and consists of a Geiger counter surrounded by a bed of ion exchange resin. The water is admitted at a constant rate into the ion exchanger and the radioactive solids are removed and counted by the Geiger counter. The effect of different types of contamination was determined. (J.S.R.)

22478 NEW QUENCHING CIRCUIT OF HIGH QUENCHING POWER AND HIGH SENSITIVITY. B. Kalab. (Universität, Vienna). *J. Sci. Instr.*, 38: 253-7 (June 1961).

A circuit is described that produces rectangular quenching pulses of an amplitude up to 2 kv variable from zero to the maximum value. The change in voltage across the counter is independent of the counting rate. An amplifier of high gain can be used so that the sensitivity is 0.3 mv. Self-oscillation caused by the voltage rise at the end of the quenching period cannot appear. (auth)

22479 THE IMPROVED f/10 SWEEPING-IMAGE CAMERA: A VERSATILE MODEL FOR EXPLOSIVE RESEARCH. Berlyn Brixner (Los Alamos Scientific Lab., N. Mex.). *J. Soc. Motion Picture Television Engrs.*, 70: 180-8 (Mar. 1961).

The previously described f/10 sweeping-image camera was equipped with a series of refined accessories to adapt it for a wide variety of explosive research problems. In order that the camera may be used with an assortment of objective lenses, it was equipped with the following adjustable accessories: camera and lens mounts, demountable lenses, remote-control focusing, slit holder mount, field lens mount and viewfinder. Attachments which help in obtaining the correct relative adjustment between the object and the final image are an illuminated-slit projector, a precision mount for the astigmatism correcting lens, and a sweeping-image viewer. To safeguard personnel in the event of a mirror explosion during camera operation, an armor plating was installed. (auth)

22480 THE SIMPLE MICROSCALE DIFFERENTIAL THERMAL ANALYSIS OF EXPLOSIVES. R. N. Rogers (Los Alamos Scientific Lab., N. Mex.). *Microchem. J.*, 5: 91-9 (1961).

The design, construction material, operation, and performance of a differential thermal analysis (DTA) cell capable of obtaining good DTA curves on samples smaller than 10 mg are given. Interchangeable, expendable cell components are used. The cell consists of a stainless steel hypodermic tube, 0.139-in. OD, 1.25 in. long, and is reamed to accept a 0.115-in. thermocouple insulators. There are also cement plugs, thermocouples, and two compartments, a sample and a reference compartment, provided within the cell. The furnace design is also described. The DTA curves of several common explosives, run at a heating rate of $11^{\circ}\text{C}/\text{min}$, are shown. (N.W.R.)

22481 COMPARISON OF HELIUM AND ARGON IN IONIZATION DETECTORS. R. Berry (United Kingdom Atomic Energy Authority, Warrington, Lancs, Eng.). *Nature*, 190: 1187-8 (June 24, 1961).

The use of He in an Ar-type detector was evaluated. Despite the differences in sensitivity and linearity of the two gases, estimates of detection limits are of the same order of magnitude. (P.C.H.)

22482 MEASUREMENT OF THE X-RAY SPECTRUM WITH A SCINTILLATION SPECTROMETER. I. PRIMARY X-RAYS. C. Takei (Nagasaki Univ.). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 1266-71 (1959).

By means of a scintillation spectrometer employing a 1-in.-dia sodium iodide crystal and a single channel pulse height analyzer, the spectral distribution of primary x rays from a tungsten target were measured. It is important in estimating the biological effects induced by x rays to know the half value layer, quantity of x rays, and the energy spectrum, as it becomes possible from the energy spectrum to calculate the correct air dose and the relative absorbed dose in the bone and soft tissue. (Abstr. Japan Med., 1: No. 8, 1961)

22483 THE BUBBLE CHAMBER. André Rousset (Ecole Nationale Supérieure des Mines, Paris). *Nucleus* (Paris), No. 2, 97-106 (Mar.-Apr. 1961). (In French)

A review is given of the principles and development of bubble chambers. Engineering problems in their construction are summarized. The experimental possibilities realizable with these detection devices are indicated. (J.S.R.)

22484 ON THE EFFECT OF BETA-RAYS ON THE GAMMA-RAY SPECTROMETRY. Tamaki Watanabe (Ja-

pan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 8: 11-16(Mar. 1959). (In Japanese)

The NaI scintillator used to measure gamma energy is canned in a thin aluminum capsule. Soft beta rays cannot penetrate the capsule, but hard beta-rays can. Consequently, for a γ emitter with hard beta rays, the gamma spectrum is materially affected by the beta rays; that is, some small photopeaks in the gamma spectrum are covered by the hard beta background. To avoid this distortion, the NaI scintillator may be covered with a thick plastic plate that absorbs the beta rays. The effect of this plate, lucite, is shown by measuring the half life of arsenic-76. (N.W.R.)

22485 DETERMINATION OF ^{137}Cs CONTENT IN THE SAMPLE CONTAINING ^{137}Cs AND ^{40}K WITH A MULTICHANNEL PULSE HEIGHT ANALYZER. Masaharu Okano (Inst. of Physical and Chemical Research, Japan) and Rumiko Inoue. Radioisotopes (Tokyo), 9: 89-95(Sept. 1960). (In Japanese)

A soil sample was treated chemically to make a solution containing Cs and K. It was then analyzed with a scintillation γ -spectrometer and the Cs^{137} and K^{40} photopeaks were measured. It was concluded that for a given phosphor and sample concentration, the error decreases with increased sample. For larger sample volume, where efficiency decreases too much, this becomes less effective. Larger crystals seem to be preferable for getting large values of counting rate (k) and efficiency (e). However, they do not improve sensitivity, but do reduce counting time. (P.C.H.)

22486 THE MEASUREMENT OF RADIANT ENERGY LEVELS IN DIAGNOSTIC ROENTGENOLOGY. Russell H. Morgan (Johns Hopkins Hospital, Baltimore). Radiology, 76: 867-76(June 1961).

The design and performance are discussed of an x ray monitor that measures total radiant energy projected on patients during radiographic and fluoroscopic exposures. Although the instrument was designed for use in epidemiological research, its simplicity of use plus its provision of radiation measurements in absolute terms makes it ideal for the routine recording of radiation exposure data in diagnostic x ray practice. (C.H.)

22487 APPLICATION OF GAMMA RELAY IN DETERMINING ABSOLUTE VISCOSITY OF LIQUID. A. Popesku and I. Karabogdan. Rev. electrotech. energet., Acad. rep. populaire Roumaine, 5: 451-8(1960). (In Russian)

The suggested γ -relay method (by dropping a radioactive ball) is capable of measuring dynamic viscosity inside a container. This is accomplished by erecting the γ -relay apparatus outside the container and inserting a starting device with automatic distance control. (R.V.J.)

22488 PRINCIPLES OF RADIATION MEASUREMENTS. A. LaGasse (Université Libre, Brussels). Rev. M.B.L.E., 4: No. 1, 33-45(Apr. 1961). (In French).

The effect of the aleatory character of the phenomena arising during radiation measurement on the results of these measurements is described in general terms. The origins of this aleatory characteristic are then examined. The distribution law of probabilities, relative to the number of pulses registered, is given. The basic elements of mathematical statistics, which furnish the justification of the methods used and permit the evaluation of the statistical error, are reviewed. A brief analysis of the effect of the self-movement of detection apparatus on the precision of the measurements and some considerations on the corrections necessitated by the resolution time of the apparatus are presented in conclusion. (tr-auth)

22489 DEVELOPMENT OF THE SPARK CHAMBER: A REVIEW. Arthur Roberts (Argonne National Lab., Ill.). Rev. Sci. Instr., 32: 482-5(May 1961).

A survey of the development of the spark chamber from the spark counter is given. An effort is made to clarify the early history of the device. Some recent Russian work on spark chambers is summarized. A consistent terminology for the various times relevant to spark chamber operation is suggested. (auth)

22490 OBSERVATIONS ON PULSED SPARK CHAMBERS. Joachim Fischer and Gus T. Zorn (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 32: 499-511(May 1961).

The spark formation time in rare-gas pulsed spark chamber is investigated as a function of the pulse voltage under various configurations of electrodes, gap lengths, gases, delay times, and clearing fields. An explanation of the formation times is found in terms of a simple process of electron multiplication leading to rapid gas breakdown. The construction of a thin foil spark chamber and thyatron pulsers for use with spark chambers are also discussed. (auth)

22491 A $14 \times 14 \times 7$ -IN. THIN PLATE SPARK CHAMBER. Donald I. Meyer and Kent M. Terwilliger (Univ. of Michigan, Ann Arbor). Rev. Sci. Instr., 32: 512-15(May 1961).

A Lucite wall spark chamber, with 0.012-in.-thick aluminum electrodes and active dimensions of $14 \times 14 \times 7$ in. is constructed and tested both with cosmic rays and a particle beam. The gap efficiency is nearly 100% and the time resolution $\sim 1 \mu\text{sec}$. Construction methods and chamber characteristics are presented. (auth)

22492 ACCURACY OF TRACK LOCATION IN SPARK CHAMBERS. [PART] I. J. G. Rutherglen and J. M. Patterson (Univ. of Glasgow). Rev. Sci. Instr., 32: 519-21(May 1961).

Several spark chambers with a sensitive area of about 6×6 in. are constructed using 0.005 in.-thick aluminum plates as electrodes and 0.25-in. glass frames as spacers. These are tested with cosmic rays, using neon, argon, and neon-argon mixtures as the filling gas. A spark gap triggered by scintillation counters is used to apply a high voltage pulse to the plates. Photographs of the sparks produced are analyzed to determine the accuracy with which the track of the cosmic ray can be located. It is found that the electrons nearest the negative electrode are the ones that determine the position of the spark. The results give a basis on which to design a spark chamber system to give any desired accuracy of track location and direction. (auth)

22493 ACCURACY OF TRACK LOCATION IN SPARK CHAMBERS. [PART] II. J. G. Rutherglen and J. M. Patterson (Univ. of Glasgow). Rev. Sci. Instr., 32: 522-3(May 1961).

The accuracy of location of a particle track in a spark chamber is studied. Effects of track angles, time delays, and clearing fields are considered. The chamber has Al electrodes 0.005 in. thick and a 6×6 in. sensitive area. The spark is triggered by a scintillation counter with a minimum delay time of 0.19 μsec . He and Ar-He mixtures are used as filling gases. (T.F.H.)

22494 REPORT ON SPARK CHAMBER WORK AT NEVIS LABORATORY. L. M. Lederman (Columbia Univ., New York). Rev. Sci. Instr., 32: 523-7(May 1961).

Design techniques for spark chambers are described. Flat plate d-c chambers of various geometries, and a rectangular 9 kMc microwave resonant cavity chamber, are

outlined. Coincidence, anticoincidence, and other methods for discharging the spark, as well as the spark characteristics, are studied. A high voltage switch and a pulsing circuit are shown. It is noted that spark chamber photographs may be scanned automatically. (T.F.H.)

2495 REPORT ON SPARK CHAMBER WORK AT PRINCETON. G. K. O'Neill (Princeton Univ., N. J.). *Rev. Sci. Instr.*, 32: 528-9 (May 1961).

Preliminary design studies are reported for a 128-gap $12 \times 12 \times 24$ in. spark chamber. The chamber is designed to give momentum measurements to 1% accuracy at 1 Bev/c. (T.F.H.)

2496 AUTOMATIC SCANNING OF SPARK CHAMBER PHOTOGRAPHS. L. J. Koester, Jr. (Univ. of Illinois, Urbana). *Rev. Sci. Instr.*, 32: 529-30 (May 1961).

Situations under which automatic scanning of spark chamber photographs is advantageous are described. Scanning methods employing digital computers, specialized instruments, and combinations of these two are discussed. A technique is considered in which the infrared radiation following the spark is scanned by infrared detectors, thus eliminating the need for photographs. (T.F.H.)

2497 KINEMATICAL ANALYSIS OF INTERACTION VERTICES FROM BUBBLE CHAMBER DATA. J. Peter (Univ. of California, Berkeley), Frank T. Solmitz, and Horace D. Taft. *Rev. Sci. Instr.*, 32: 538-48 (May 1961). A high speed computer program for the kinematical analysis of bubble chamber events is described. The program treats individual particle interaction or decay vertices, projecting the measured variables to the equations of energy and momentum according to a least-squares criterion. This process is carried out in four different cases in which the problem is overdetermined, and in a fifth case in which the problem is just determined. The adjusted or computed variables corresponding to each particle, as well as the first-order error matrices for each type of variable, are obtained in all cases. A connected chain of vertices may be processed in sequence. (auth)

2498 STABILIZED SCINTILLATION COUNTER. S. A. Scherbatskoy (Geophysical Measurements Corp., Tulsa, Okla.). *Rev. Sci. Instr.*, 32: 599-600 (May 1961).

A scintillation counter spectrometer is described that is stabilized against temperature drifts, changes with time, and variations between photomultiplier tubes. A standard light pulse is used, whose amplitude is constant and larger than any amplitude in the spectrum being studied. These "pilot" pulses are amplified and fed into a feedback circuit that controls the photomultiplier high-voltage supply. Thus the pilot pulses retain a constant height, and the gain of the system remains constant. (T.F.H.)

2499 CONICAL TWO-CRYSTAL MONOCHROMATOR FOR SCATTERING, DIFFRACTION, AND ADSORPTION CROSS SECTION WORK WITH SLOW NEUTRONS. K. Das Gupta (University Coll. of Science, Calcutta). *Rev. Sci. Instr.*, 32: 602-3 (May 1961).

A conical two crystal slow neutron monochromator is described. A cylindrical annulus of neutrons is incident on a coaxial conical face of the first crystal at a small angle θ . The neutrons are then scattered into the coaxial conical face of the second crystal at a small angle θ' . The neutron beam emerging from the second crystal is convergent, conical, and monochromatic. Variations in the angles θ and θ' between about 30° and 10° , and the use of various crystals (NaCl or mica) give differing neutron energies. (T.F.H.)

22500 THIN CsI(Tl) SCINTILLATING LAYERS PRODUCED BY VACUUM DEPOSITION. Gunnar Aniansson (Royal Inst. of Tech., Stockholm). *Trans. Roy. Inst. Technol. Stockholm*, No. 176, 1-21 (1961). (In English)

In the scintillation counting of particles of the lowest detectable energy in the presence of particles of much higher energy, the problems inherent in amplifier overload and base line shift may be circumvented by using sufficiently thin scintillators. The preparation by vacuum deposition of CsI (Tl) layers of thicknesses around 10^{-3} mm and of Tl contents from 0.1 to 90% is described. The scintillation properties of these films under α excitation are evaluated. (auth)

22501 APPARATUS FOR MEASURING α -PARTICLE RANGES IN LIQUIDS. Gunnar Aniansson (Royal Inst. of Tech., Stockholm). *Trans. Roy. Inst. Technol. Stockholm*, No. 177, 1-44 (1961). (In English)

An apparatus is described for measuring the ranges in liquids of α particles from radioactive substances. The accuracy is about 0.1% for range measurements of the order of 50μ . (auth)

22502 WALL THICKNESS MEASUREMENTS BY THE PULSE METHOD. A. Z. Raikhan (State Trust for the Organization and the Improvement of Regional Electric Systems [USSR]). *Zavodskaya Lab.*, 27: 169-70 (1961). (In Russian)

The ultrasonic method of wall thickness measurement of pipes cannot be used without good acoustic contact between the ultrasonic generating device and the wall. A new method was developed for calculating the wall thickness on the basis of the time needed for passage of the single or multiple reflections of an ultrasonic signal in lengthwise and transversal direction in Plexiglas and in steel. The relative error of measurement in the 4 to 12 mm thickness range amounts to about 3.5%, using a defectoscope. The method is useful for detecting scaling defects. (TTT)

22503 DOSIMETRY TECHNIQUES FOR ENVIRONMENTAL TESTING. J. F. Kircher and Mary J. Oestmann (Battelle Memorial Inst., Columbus, Ohio). p. 150-5 of "1959 Proceedings Institute of Environmental Sciences Annual Technical Meeting Held April 22, 23, 24, 1959, Chicago, Illinois." Mt. Prospect, Illinois, Institute of Environmental Sciences.

The characteristics and ranges of application of various dosimeters for gamma rays and neutrons are discussed. Types of dosimeters considered are chemical, calorimetric, glass, solid state, foil and wire, nuclear reaction, and ionization. (D.E.B.)

22504 INTEGRAL POSITIONING AND INDICATING DEVICE. Charles E. Frantz, William E. Cawley, and Robert F. Warnick (to U. S. Atomic Energy Commission). U. S. Patent 2,994,019. July 25, 1961.

A variable capacitor which may be used as an integral positioning and indicating device is described. The apparatus comprises a hollow metal cylinder with a metal rod mounted fixedly along the axis thereof and insulated therefrom. A hollow shaft is slidably mounted between the cylinder and the rod in electrical connection with the cylinder and insulated from the rod. One end of the shaft is disposed between the cylinder and the rod and the other end extends therefrom and may be connected to an object whose position is to be monitored. Means are provided to move the hollow shaft by pressure fluid in the cylinder whereby the capacitance between the rod and the cylinder is varied and measurement of which is a function of the position of the hollow shaft.

22505 ELECTRICAL LOAD ANTICIPATOR AND RECORDER. J. B. Russell and R. J. Thomas (to U. S. Atomic Energy Commission). U. S. Patent 2,994,038. July 25, 1961.

A system is described in which an indication of the prevailing energy consumption in an electrical power metering system and a projected power demand for one demand interval is provided at selected increments of time within the demand interval. Each watt-hour meter in the system is provided with an impulse generator that generates two impulses for each revolution of the meter disc. The total pulses received from all the meters are continuously totaled and are fed to a plurality of parallel connected gated counters. Each counter has its gate opened at different sub-time intervals during the demand interval. A multiplier is connected to each of the gated counters except the last one and each multiplier is provided with a different multiplier constant so as to provide an estimate of the power to be drawn over the entire demand interval at the end of each of the different sub-time intervals. Means are provided for recording the outputs from the different circuits in synchronism with the actuation of each gate circuit.

22506 PHOTOELECTRIC CONTROL FOR TAPE POSITIONING. J. W. Woody, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,994,072. July 25, 1961.

A control system is described for producing control impulses which may be used to start, stop, and position a magnetic tape with respect to a transducer, and to locate discrete areas on the tape. Means are provided for positive identification of data blocks, exact positioning of the tape under the magnetic head, drive in either direction, accurate skip-over of imperfect regions of the tape, stopping the tape if equipment malfunction results in a failure to detect the block-identifying signals, and starting and stopping those parts of the tape between of the tape drive clutches.

Materials Testing

22507 (ER-10911-3) EVALUATION OF ULTRASONIC TEST DEVICES FOR INSPECTION OF ADHESIVE BONDS. Quarterly Progress Report No. 3, January 1, 1960 through March 31, 1960. John P. Reese, Von H. Boruff, and H. L. Parent (Martin Co., Baltimore). Apr. 1960. Contract NOas 59-6266-c. 51p.

Non-destructive and destructive tests were completed on metal laminates using four ultrasonic test devices for inspection of adhesive bonds. Generally the instruments can distinguish bond defects such as voids and porosity from control bonds, as well as variations in glue line thickness. However, none could separate low strength bonds due to poor surface preparation or undercured adhesive from the control bond. (auth)

22508 (TID-5147(Del.)) TECHNICAL PAPERS OF THE SEVENTH METALLOGRAPHIC GROUP MEETING [HELD AT PENNSYLVANIA ELECTRIC PRODUCTS, INC. ON] MAY 7, 1953. H. P. Roth, comp. (Metallurgy Development Advisory Committee, AEC). Dec. 8, 1953. Decl. with deletions Mar. 1, 1957. 94p.

Ten papers presented at the Seventh Metallographic Group Meeting, May 7, 1953 are given. Topics covered include: specimen preparation for electron metallography, development of remote metallographic polishing techniques, preparation of metallographic specimens from irradiated metals, metallography of U-Zr alloys, cathodic vacuum etching procedure, etching of thorium and its alloys by electrochemical reagents and ionic bombardment, carbide precipitation study in Inconel, mounting resin for metallographic specimens, specimen mounting in casting resin, and martensite transformation in U-Cr alloys. (M.C.G.)

22509 (NP-tr-610) METHOD OF DETERMINING THE TENSILE STRENGTH OF METALS. G. V. Uzhik. Translated from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, No. 10, 1547-60(1948). 21p.

The increase of strength of a plastic metal specimen upon the application of a groove is studied. A new property, resistance to tear, may be determined in this way and is distinguished by the fact that it is not accompanied by plastic strain in the area of greatest stress. A procedure is proposed for determining this property. (D.L.C.)

22510 INSPECTING FUEL-SLUG CLADDING AT HANFORD AUTOMATICALLY. Daniel C. Worlton (General Electric Co., Richland, Wash.). Nucleonics, 19: No. 7, 92; 94; 96; 98(July 1961).

Hollow cylindrical fuel elements at Hanford are clad by brazing the fuel slugs to Al cans, using an Al-Si bonding agent. Automatic systems are used to inspect the integrity of the bonds, by analyzing the echoes to ultrasonic pulses. Defects such as gas pockets, non-wets, brittle bonds, and thin spots in the cladding are detected by this method. (T.F.H.)

22511 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV V DEFEKTOSKOPII. RUKOVODSTVO PO RADIOAKTIVNYKH IZOTOPOV V PROMYSHLENNOI DEFEKTOSKOPII. (Applications of Radioactive Isotopes in Defectoscopy. A Manual of Radioisotopes in Industrial Defectoscopy). S. V. Rumyantsev. Moscow, Atomizdat, 1960. 294p.

Applications of radioisotopes in metal and finished product defectoscopy are reviewed. The physical and technological bases of radioisotope defectoscopy are analyzed, and operational techniques, equipment, and safety measures are discussed. Special attention is given to heavy-metal (Ti, Al, and Mg), thin-wall defectoscopy using Cs^{137} , Eu^{152} , Eu^{154} , Ir^{192} , Se^{75} , Tm^{170} , Eu^{155} , and Ce^{144} . (R.V.J.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

2512 (AD-251763) APPLICATION OF WEATHER RADAR TO FALLOUT PREDUCTION. Quarterly Technical Report No. 11, Covering Period September 1, 1960 through November 30, 1960. Pauline M. Austin (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). Dec. 15, 1960. Contract DA-36-039 SC-75030. 16p.

The investigation of the application of radar to the prediction of radioactive rainout resulting from a nuclear detonation was continued. Records of a number of hours' duration were obtained in 6 storms. These included the rainstorm associated with Hurricane Donna on September 12, 1960. Comparisons of simultaneous measurements on the two radars indicated that the discrepancy between their relative values is only 2 to 3 db. Computations and measurements are being made to determine the cause of the difference. Data from summertime storms were transcribed to the form of intensity contour maps. Work was continued on the digitalization and numerical analysis of quality line data. The computer program for obtaining fallout and rainout patterns for a 10 kt detonation was completed and tested. For a selected wind field, a distribution in the absence of precipitation and two distributions with snow showers were computed. (auth)

2513 (AFCRL-TR-60-411) STUDIES ON METEORITES. Final Report. H. Wänke and H. König (Max-Planck-Institut für Chemie, Mainz). 1960. Contract AF61(514)-332. 73p.

A total of three papers are included all of which were previously abstracted in NSA. (J.R.D.)

2514 (AFCRL-TR-60-411(p.1-18)) AGE DETERMINATIONS ON STONE METEORITES WITH THE POTASSIUM-ARGON METHOD USING A NEWLY DEVELOPED TECHNIQUE. H. Wänke and H. König (Max-Planck-Institut für Chemie, Mainz).

Also published in *Z. Naturforsch.*, 14a: 860-6(Oct. 1959). In German)

This paper was previously abstracted from the original language and appears in NSA, Volume 14, abstract no. 627.

2515 (AFCRL-TR-60-411(p.19-61)) SCANDIUM 45 AS SPALLATION PRODUCT OF THE COSMIC RAYS IN IRON METEORITES. H. Wänke (Max-Planck-Institut für Chemie, Mainz).

Also published in *Z. Naturforsch.*, 13a: 645-9(Aug. 1958). (In German)

This paper was previously abstracted from the original language and appears in NSA, Volume 12, abstract no. 7496.

2516 (AFCRL-TR-60-411(p.62-74)) THE POTASSIUM CONTENT OF CHONDRITES, ACHONDRITES, AND HEDERITES. H. Wänke (Max-Planck-Institut für Chemie, Mainz).

Also published in *Z. Naturforsch.*, 16a: 127-31(Jan. 1961). (In German)

This paper was previously abstracted from the original language and appears in NSA, Volume 15, abstract no. 4906.

2517 (BNL-652) A STUDY OF THE WIND PROFILE IN THE LOWEST 400 FEET OF THE ATMOSPHERE.

Progress Report No. 8, September 16, 1960-January 15, 1961. Irving A. Singer and Constance M. Nagle (Brookhaven National Lab., Upton, N. Y.). Jan. 1961. Contract R-65-8-99812 SC-04-91. 28p.

The analysis of errors in predicting upper level wind speeds from speeds at a lower reference level by using an unweighted predictor of varying averaging length and relative displacement in time was continued. Previously this analysis was always a "forecast," with the mean at the reference level starting before the mean at the prediction level. The same data were used to make a "hindcast," and the results were evaluated. A detailed study was completed of the variation of p (obtained from the power law) with solar time and wind speed. In previous analyses it was noted that the mean wind speed does not always increase with height. An outline is given of the theoretical approach to be used in evaluating this condition. Test procedures to evaluate the effect of displacing the reference level horizontally are described. A 50-ft portable mast will record data at distances up to 750 ft from the meteorological tower. (auth)

22518 (IA-524) SOIL ANALYSES IN CONNECTION WITH CONTAMINATION PROBLEMS. Irene Schoenfeld (Israel. Atomic Energy Commission, Tel-Aviv). Apr. 1961. 42p.

In connection with a study of the Sr^{90} contamination of natural media, the properties of typical Israeli soils were examined. The characteristic calcium-rich nature of the majority of these soils was taken into account in the development of suitable methods of analysis. Standard methods are evaluated and adaptations of them suitable for the local conditions are described. Determinations described include mechanical analysis, moisture, pH, CaCO_3 , exchangeable calcium and total cation exchange capacity of the soils. Calculated and experimental values for cation exchange capacity are compared and seasonal changes in the various soil parameters are noted. (auth)

22519 (LAMS-2536) ARTIFICIAL AURORA AND UPPER ATMOSPHERIC SHOCK PRODUCED BY TEAK. Herman Hoerlin (Los Alamos Scientific Lab., N. Mex.). Mar. 2, 1961. Contract W-7405-ENG-36. 18p.

The northern branch of the artificial aurora and the features of the upper atmospheric shock produced by shot Teak exploded at 252,000 ft above Johnston Island are described and analyzed. The correlation between the brightness-time history of the aurora and the decay of fission products is qualitatively good and a rather high conversion efficiency (~10%) for light emission is indicated. A pronounced slowing down of the upper shock was observed which was caused by work against the geomagnetic field. The deep red appearance of this shock is believed to be due to excitation of the red auroral oxygen lines. The correlation between observed shock brightness and the light emission calculated on the basis of the computed shock temperature is discussed. The surprisingly high magnitude of the observed brightness of the front at +500 km is probably the result of interaction of the shock front with the compressed geomagnetic field. (auth)

22520 (MITS-45) THE ADAPTATION OF NEW RESEARCH TECHNIQUES TO MINERAL ENGINEERING PROBLEMS. A Semi-Annual Progress Report for the Six-Month Period Ending October 31, 1960. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Contract AT(30-1)-956. 70p.

Reproducible reversible precipitates were prepared and an investigation of the surface properties of these systems in the presence of cationic surfactants were begun. The procedure for preparation is given and results of experiments

to determine the specific surface of fine ferric oxide precipitate by negative adsorption are tabulated. Resolution of the problem involving electrode polarization during streaming potential measurements by continuous recording of electrode response to flow is reported. It is noted that this method eliminates arbitrariness which is associated with the method in which an algebraic polarization potential subtraction is made. Preparation of high-purity sodium dodecyl sulfonate for adsorption studies is described and experiments in which the distribution of this compound between water and octane are discussed. Data from experiments on hysteresis of contact angles using mercury-water-benzene system are given along with similar data using benzene-water quartz. Studies of the kinetics of flotation are reported based on a theory in which the only major restriction is the use of Stokes' equation for flow of a liquid around a sphere. In other work batch flotation test were conducted in three geometrically similar cells. Pure quartz powder was used as the feed while dodecyl ammonium acetate was used as a collector and frother. Further work is reported on construction and testing of a high pressure autoclave, testing and improvement of analytical methods, and a study of zinc sulfide precipitate. Leaching tests are also reported. An analysis of thickening and thickeners was made. A mathematical model of brittle fracture was derived. (J.R.D.)

22521 (NP-10331) ON THE LATERAL DISTRIBUTION OF LARGE PARTICLES FROM A 15 M SOURCE IN THE ATMOSPHERE. Suffield Technical Paper No. 211. K. D. Hage and J. V. Zidek (Canada. Suffield Experimental Station, Ralston, Alberta). Apr. 28, 1961. 15p.

Lateral deposit densities on selected sampling arcs to a distance of 200 m. downwind from a continuous point source at 15 m were correlated linearly with frequency distributions of wind direction measured at the source and with Gaussian approximations to the wind direction distributions. Correlation coefficients, significant at the 5% level, were found in 6 out of 7 trials. It was not possible to establish significant differences in the performances of the two variations of the prediction technique. Some evidence is provided to show that frequency distributions based on 5 or 10 second averages of wind direction yield predictions which are superior to those based on 20 second averages. The prediction technique appears to be less satisfactory at 200 m than at distances closer to the source. (auth)

22522 (SCTM-195-53(51)) REFLECTION COEFFICIENTS OF THE EARTH'S SURFACE AT VHF (30-300 mc). D. K. Robbins (Sandia Corp., Albuquerque, N. Mex.). Jan. 8, 1954. 40p.

The means for determining the reflection coefficient, R , of the earth's surface are discussed. The two basic ways are by direct measurement and by measurement of the earth's constants (dielectric constant, ϵ , and conductivity, σ) from which the reflection coefficient can be calculated from Fresnel's equation. The variation of ϵ and σ with temperature and frequency (in the VHF range, 30 to 300 mc) for water (both salt and fresh) and soil was graphed to the extent of the data available in the literature. From this it was possible to calculate the effect of these variables on R . The variation of the depth of penetration of the electromagnetic waves into soil with frequency and ϵ and σ was also studied. A number of reflection coefficients in the VHF range are listed. This list represents a general survey of the available literature on earth's constants and reflection coefficients. (auth)

22523 (TEI-772) INTERIM REPORT ON GEOLOGIC INVESTIGATIONS OF THE U12e TUNNEL SYSTEM, NEVADA TEST SITE, NYE COUNTY, NEVADA. F. A.

McKeown and D. D. Dickey (Geological Survey, Washington, D. C.). Sept. 1960. 130p.

A summary is presented of the geology of the U12e tunnel system in the form of maps and tables. The parts of the U12e tunnel system described consist of a 5700-ft main tunnel, U12e, and five lateral tunnels, U12e.01, U12e.02, U12e.03, U12e.04, and U12e.05, totaling about 8900 ft. Chemical and semiquantitative spectrographic analyses results are tabulated for samples of tuff taken from the tunnel system. (B.O.G.)

22524 (TEI-777) GEOLOGIC INVESTIGATIONS OF RADIOACTIVE DEPOSITS, 1942-1960. A Bibliography of U. S. Geological Survey Publications on the Geology of Radioactive Deposits. Andrew Brown (Geological Survey, Washington, D. C.). Jan. 1961. 86p.

A bibliography of Geological Survey publications resulting from investigations of radioactive materials and deposits since 1942. The listings are complete as of November 30, 1960 and include 682 references. Entries are arranged under the following main headings: general publications on uranium and thorium, reconnaissance for uranium and thorium, uranium in sandstone-type deposits, uranium in carbonaceous materials, uranium in phosphates, uranium in limestones, investigations of thorium and related elements, and beryllium investigations. (M.C.G.)

22525 (TEI-779) GEOLOGIC INVESTIGATIONS IN SUPPORT OF PROJECT CHARIOT, PHASE III, IN THE VICINITY OF CAPE THOMPSON, NORTHWESTERN ALASKA—PRELIMINARY REPORT. Reuben Kachadoorian, Russell H. Campbell, George W. Moore, David W. Scholl, Arthur H. Lachenbruch, Gordon W. Greene, B. Vaughn Marshall, David F. Barnes, Rex V. Allen, Roger M. Waller, and Marvin J. Slaughter (Geological Survey, Washington, D. C.). Jan. 1961. 104p.

Geologic investigations were made at the Chariot test site, at the mouth of Ogotoruk Creek in the vicinity of Cape Thompson, Alaska. In the area within a 15-mile radius of the site, bedrock consists entirely of consolidated clastic and chemical sediments. The test excavation lies entirely in frozen mudstone which is complexly folded and faulted. Moisture determinations conducted within 10 ft of the surface indicated that the moisture content of the rock ranges from 3.1% in the thawed mudstone to 12.5% in the frozen mudstone. The use of refrigerated diesel fuel as drilling fluid in Holes Charlie and Dog in 1960 overcame the collapse of drill-hole walls owing to thawing of permafrost experienced in drilling by conventional techniques. Work on coastal processes was focused on establishing a physical background for ecological studies being conducted by other investigators and on characterizing the natural movement of sediment as an aid in evaluating the success and safety of the proposed nuclear test. Piston-core samples from lagoons which do not contain the mouths of rivers and streams showed that only about 10 cm of sediment were laid down in the lagoons since the last major rise of sea level. The shoreline history of the area was inferred from these samples. The two new holes were used to provide temperature information needed for a quantitative evaluation of the thermal regime of lower Ogotoruk Creek Valley. The thermal regime of permafrost was found to not be in equilibrium with the present position of the shoreline or the present climate. Preliminary calculations indicated that the flow of heat to the surface from the earth's interior is on the order of one-millionth of a calorie per square centimeter of surface per second. A series of gravity measurements between Kotzebue and Point Hope indicated a broad uneven gravity low with double minimums near

pe Seppings and Kivalina. The possibility of radioactive contamination of shallow and deep aquifers existing in the sea was investigated. (M.C.G.)

2526 (TID-12829) VERTICAL PROFILES OF CONDENSATION NUCLEI IN THE STRATOSPHERE. Chris-
n E. Junge (Air Force Cambridge Research Labs.,
dford, Mass.). Jan. 1960. 35p.

Seven vertical profiles of Aitken nuclei in the upper tro-
sphere and stratosphere are discussed. Average values
are presented and compared with previous tropospheric
data. The main features of the vertical profiles are ex-
plained by processes of washout, coagulation, and eddy
diffusion. (auth)

2527 (TID-13001) GEOLOGIC ASPECTS OF THORIUM
RECOVERY FROM COMMON ROCKS. Annual Report,
June 1, 1960 through May 31, 1961. (Rice Univ., Houston,
Tex.). For Oak Ridge National Lab. Contract W-7405-eng-
61, Subcontract 1491. 19p.

Collection and analysis of rock specimens for Th re-
covery are reported. Investigations revealed that Conway
granite of N. H. is usually high in Th and covers an exten-
sive area. High Th concentrations also occur in Vt. and
Maine areas. Lateritic soils may be a low-grade source of
Th. In other work, development of a gamma-ray pulse
height analyzer for determination of Th in the field is re-
ported. (J.R.D.)

2528 (AEC-tr-4474(p.240-91)) THE ROLE OF ISO-
TOPE ANALYSIS OF LEAD IN DETERMINATION OF GEO-
LOGICAL AGE. G. V. Avdzyko. Translated from Trudy
Radiyevogo Inst. im. V. G. Khlopina, 8: 198-240(1958).

Data are presented on the Pb isotopic composition in
USSR radioactive minerals. It was found that ordinary Pb
contamination of most uraninites and monazites does not
exceed 3% of the total Pb content, but that considerable
contamination (up to 50%) occurs in pitchblende minerals
of hydrothermal deposits. The most probable age for ura-
nium minerals is the age calculated on the basis of the
 Pb^{207}/U and Pb^{207}/Pb^{206} ratios and for monazites is the age
calculated on the basis of the Pb^{208}/Th ratio. Emanation
coefficients of Rn , Rn^{219} , and Rn^{220} were determined for
several uraninites. Age characteristics calculated for a large
number of USSR pre-Cambrian formations are presented.
The isotopic composition and age of ore leads are dis-
cussed. (D.L.C.)

2529 (AEC-tr-4474(p.292-302)) THE THORITES OF
THE MIDDLE-DNIEPER REGION. M. S. Filippov and
V. V. Komlev. Translated from Trudy Radiyevogo Inst.
im. V. G. Khlopina, 8: 241-9(1958).

Granites of the Dnieper-Tokov magmatic complex con-
tain large amounts of radioactive elements, particularly
Th, and are the most active of all Ukrainian granites.
Study of the heavy accessory minerals from the granites
revealed three accessory thorites: ferrithorite, phospho-
thorite, and uranothorite. The thorites are closely associ-
ated with black zircon and ore minerals. The modes of
occurrence of the thorites are given. (D.L.C.)

2530 (AEC-tr-4474(p.303-18)) URANIUM CONTENT
IN NATURAL WATERS OF THE USSR. I. E. (Ye.) Starik,
S. B. Nikola'ev (Nikolayev), F. E. (Ye.) Starik, and O. S.
Belikova. Translated from Trudy Radiyevogo Inst. im.
V. G. Khlopina, 8: 250-61(1958).

A large number of water samples taken from the rivers,
lakes, and underwaters of USSR were analyzed for
their uranium content. The resulting data are tabulated.
(D.L.C.)

22531 (AEC-tr-4474(p.319-32)) SOME REGULARI-
TIES OF URANIUM MIGRATION IN WATERS OF NORTH-
WESTERN DISTRICTS OF USSR. A. Ya. Krylov and M. M.
Shats. Translated from Trudy Radiyevogo Inst. im. V. G.
Khlopina, 8: 262-73(1958).

Data on the uranium contents of some water bodies in
northwestern USSR are presented. The factors influencing
uranium transfer into and precipitation from water are
discussed at length and applied to a few examples. Pre-
cipitation of uranium is shown to occur mostly through the
action of iron hydroxide and humic compounds. (D.L.C.)

22532 (JPRS-5944) USE OF RADIOACTIVE ISOTOPES
FOR DETERMINING ATMOSPHERIC TURBULENCE.
N. N. Aleksandrov. Translated from Trudy Arktich. i
Antarktich. Nauch.-Issledovatel'. Inst., No. 226, 113-22
(1959). 15p.

A tracer technique employing Pb^{32} and gas-discharge
counters is described for measuring atmospheric turbu-
lence. (C.T.G.)

22533 NEW RESULTS FROM LEAD-ALPHA AGE
MEASUREMENTS. T. W. Stern and H. J. Rose, Jr. (U. S.
Geological Survey, Washington, D. C.). Am. Mineralogist,
46: 606-12(May-June 1961).

Improvement in the spectrochemical method for de-
termining Pb in zircon increases the usefulness of the
lead-alpha (Larsen) age method. Good agreement is found
between the lead-alpha ages and those obtained by isotope
dilution analyses on twelve samples. These samples have
calculated ages ranging from 400 to 1200 million years.
New lead analyses and revised lead-alpha ages are pre-
sented for 19 samples previously analyzed. (auth)

22534 METHODY POISKOV I RAZVEDKI MESTORO-
ZHDENII URANA. (Prospecting for Uranium Ore Deposits).
D. Ya. Surazhskii—V. I. Smirnov, ed. Moscow, Atomiz-
dat, 1960. 240p.

The handbook consists of three sections. The first is
devoted to general characteristics of uranium deposits and
basic prospecting criteria. The second describes prospect-
ing methods. The third describes the deposits according to
their morphological properties and offers various methods
for sampling and assaying ores. 220 references. (R.V.J.)

22535 THE COMPARABILITY OF RADIOACTIVITY
MEASUREMENTS. H. Isra'el. Atomkernenergie, 6: 218-
22(May 1961). (In German)

Measurements of atmospheric radioactivity has remark-
ably increased in the last decade. Nevertheless, the results
suffer frequently from insufficient comparability. Also, the
knowledge of the role played by thorium-emanation and its
daughter products is still quite incomplete. Results con-
cerning both problems are given. (auth)

22536 DISTRIBUTION OF URANIUM IN SOME META-
MORPHIC LIMESTONES NEAR CAMPIGLIA. Antonio
Longinelli (Università, Pisa, Italy). Atti. acad. nazl.
Lincei. Rend., Classe sci. fis., mat. e nat., 29: 370-6(Nov.
1960). (In Italian)

The uranium distribution in metamorphic limestones
sampled at various distances from the granite massif near
Campiglia was measured using Ilford C2 emulsions. The
values obtained are tabulated and discussed. (J.S.R.)

22537 SOME POSSIBLE GEOLOGIC RELATIONSHIPS
IN THE FORMATION OF URANIUM²³⁵ FROM CURIUM²⁴⁷.
Hans H. Adler (U. S. Atomic Energy Commission, Wash-
ington, D. C.). Econ. Geol., 56: 689-94(June-July 1961).
(RME-4093)

A mechanism for the derivation of U^{235} from Cm^{247} is

considered as a possible source of U^{235} enrichment in radioactive rare earth minerals. The presence of Cm^{247} in early earth materials is predictable on the basis of synthesis through nuclear reactions and from extrapolations of abundances of lighter nuclides. The chemistry of curium reflects a geochemical similarity to rare-earth elements and possible incorporation in rare-earth minerals. The amount of enrichment of U^{235} that might be expected from Cm^{247} decay is calculated for monazite for several geologic ages. Within the limits of the parameters considered, Cm^{247} would not provide sufficient U^{235} enrichment to be of economic consequence, but its possible existence in early geologic time may be of interest in geochronology studies. Underestimation of Cm^{247} abundance may affect significantly the probability for finding interesting variations in U^{235} : U^{238} ratios. (auth)

22538 OCCURRENCE OF RADIOACTIVE FLUORITIC SANDSTONE, WET MOUNTAINS, COLORADO. Robert E. Boyer (Univ. of Texas, Austin). *Econ. Geol.*, 56: 780-3 (June-July 1961).

Dakota sandstone with a fluorite cement containing thorium, uranium, and zirconium occurs in the proximity of a Tertiary hypabyssal rhyolite stock at the southern end of the Wet Mountains, Colorado. Field relations and proximity to the stock suggest a hydrothermal origin for the mineralization. Regional mapping indicates the age of intrusive activity is mid-Tertiary, and possibly younger. (auth)

22539 CHROMIUM, COBALT AND STRONTIUM IN SOME BUREAU OF STANDARDS ROCK REFERENCE SAMPLES. Karl K. Turekian and Michael H. Carr (Yale Univ., New Haven). *Geochim. et Cosmochim. Acta*, 24: Nos. 1/2, 1-9 (June 1961). (In English)

A method for the simultaneous determination of Cr and Co in rocks by neutron activation is described, and results on a set of rock reference samples are reported. Strontium was also determined in the same materials by an emission spectrographic method calibrated by isotope dilution standards. NBS reference materials should be used for inter-laboratory comparisons and checks of accuracy. (auth)

22540 THE TIME INTERVAL BETWEEN NUCLEOSYNTHESIS AND FORMATION OF THE EARTH. P. K. Kuroda (Univ. of Arkansas, Fayetteville). *Geochim. et Cosmochim. Acta*, 24: Nos. 1/2, 40-7 (June 1961). (In English)

The differences (δ_i) in the abundance ratios of the stable Xe isotopes in meteorites and in the earth's atmosphere indicate that the latter contains an excess of fissiogenic Xe. It is postulated that the "extinct" transuranium elements, such as Pu^{244} and Cm^{247} , played important roles in the production of the fissiogenic Xe in the earth's atmosphere. The time interval (Ξ) between the nucleosynthesis and the formation of the earth was calculated from the values of δ_i . If it is assumed that the contribution from the Cm^{247} spontaneous fission and the U^{235} neutron-induced fission was negligible, a value of $\Xi = 4.8 \times 10^8$ years is obtained for the single event model and a value of $\Xi = 0.52 \times 10^8$ years for the continuous synthesis model. (auth)

22541 PRIMORDIAL ARGON AND NEON IN CARBONACEOUS CHONDRITES AND UREILITES. Heinz Stauffer (Univ. of California, La Jolla). *Geochim. et Cosmochim. Acta*, 24: Nos. 1/2, 70-82 (June 1961). (In English)

The abundance and isotopic composition of Ar and Ne in five carbonaceous chondrites and in two ureilites were measured. The results show that these meteorites contain large amounts of trapped primordial gases. Heating experiments with only partial extraction of the rare gases were carried out, showing that at 950°K the radiogenic Ar diffuses out more readily than the primordial Ar, and cosmo-

genic Ne at about the same rate as primordial Ne. From that it is concluded that the primordial gases are enclosed within the matrix of the crystal lattice. Argon-potassium ages and Ne²¹ exposure ages were calculated. Both are affected by diffusive losses. Only Felix has an A/K age of 4.5 AE (billion years). A large loss of primordial Ar and Ne as compared to the Si is observed. The loss of primordial Ar is constant within a factor 10 for all samples, and about 10 to 100 times smaller than the loss observed for the earth. The ratios of primordial Ne²⁰ to primordial Ar³⁶ have values between 0.005 and 22, indicating large fractionation between Ar and Ne as compared to the corresponding cosmic ratio. Fractionation by diffusive losses is discussed. Some deviations of the isotopic ratios of primordial Ar and Ne from the atmospheric ratios are observed. (auth)

22542 NUCLEAR GEOLOGY: A REVIEW. U. Aswathanarayana (Andhra Univ., Waltair, India). *Indian Minerals*, 14: 342-6 (Oct.-Dec. 1960). (In English)

The decay of natural radioactive elements at a constant rate is used for the measurement of geological time. The heat generated in rocks due to radioactive disintegration has a profound bearing on the thermal history of the earth. A study of the fractionation of isotopes in nature can be helpful in the elucidation of pleotemperatures of oceans, ore genesis, temperatures of metamorphism, etc. The economic utility of nuclear geology arises from its importance in prospecting for radioactive minerals. (auth)

22543 THE INFLUENCE OF SIZE DISTRIBUTION ON THE GROUND DEPOSIT OF LARGE PARTICLES EMITTED FROM AN ELEVATED SOURCE. K. D. Hage (Suffield Experimental Station, Ralston, Alberta). *Intern. J. Air and Water Pollution*, 4: Nos. 1/2, 24-32 (June 1961). (In English)

A non-turbulent fall-out model is found to be inadequate for the prediction of the time-averaged ground deposit of nearly homogeneous nominal 100 μ diameter particles emitted from a point source at 15 m. As the heterogeneity of the particle size distribution increases, the turbulent effects are obscured by the effects of size distribution so that, for mass-diameter distributions with large standard deviations such as those commonly encountered in practice, the non-turbulent fall-out model may provide acceptable predictions of mass deposit even though individual particles are influenced appreciably by turbulent dispersion. In this circumstance, however, the range of particle sizes to be found at a fixed distance from the source according to the non-turbulent fall-out model will be much too narrow. It is essential that nearly homogeneous particles be used. (auth)

22544 SOME OBSERVATIONS ON SMOKE PLUMES. G. T. Csanady (Univ. of New South Wales). *Intern. J. Air and Water Pollution*, 4: Nos. 1/2, 47-51 (June 1961). (In English)

The plume at Tallawarra power station was photographed many times to obtain the mean position. The observations were plotted in terms of appropriate nondimensional variables and compared with others results. Within about 1500 ft from the source, good agreement with theory was found. The asymptotic plume height was found to be given crudely by the formula: $z_a = 250 F/U^3$ where U is wind speed, F "flux of buoyancy," a variable proportional to heat flux. (auth)

22545 OTHER EVIDENCES AS TO THE INCREASE OF RADIOACTIVITY OF THE FALLOUT IN CONSEQUENCE OF THE FRENCH NUCLEAR TESTS IN 1960. Vilém Santholzer, Jiří Macků, Vratislav Havlovic, and Josef Podzimek (Charles Univ., Prague). *Jaderná energie*, 7: 122-9 (Apr. 1961). (In Czech)

Evidences of increased artificial radioactivity of the atmosphere and of the atmospheric precipitations in consequence of two French nuclear tests in February and April 1960 are summarized and compared. From absorption and filterable filtration measurements it is possible to prove that samples of fallout from the end of 1960 emit β radiation of higher average maximal energy than fresh samples. The decrease of the activity can be proved also by sticking plates radiographically on X ray film. By means of an automatic measuring apparatus the decrease of activity of free fallout samples during 10 months is studied. The decrease of activity is expressed by the formula $A = at^{-n}$, n being 1.2 to 1.4. The shortest half lives in samples of the fallout are 9 to 18 days. (auth)

2546 POTASSIUM-ARGON AGES OF THE DARTMOOR AND SHAP GRANITES USING THE TOTAL VOLUME AND ISOTOPIC DILUTION TECHNIQUES OF ARGON MEASUREMENT. M. H. Dodson (Cambridge Univ., Eng.), J. A. Miller, and D. York. *Nature*, 190: 800-2 (May 27, 1961). Results are presented from K-Ar age measurements of Shap and Dartmoor granites, using both total volume and isotopic dilution techniques. Results were consistent about 1%. Mean values are 265 ± 5 million yr for the Dartmoor granites and 397 ± 8 million yr for the Shap. Results of these measurements are compared with earlier results. (C.H.)

2547 CONCENTRATION OF ATMOSPHERIC RADON AND WIND DIRECTION. F. Barreira (Centro de Física da Comissão de Estudos de Energia Nuclear, Lisbon). *Nature*, 190: 1092-3 (June 17, 1961).

The concentration of radon in the air was measured, and wind directions were recorded in 16 directions. It was concluded that continental winds are generally related to higher concentrations of atmospheric radon. Sharp maxima were observed in the directions passing over the regions where uranium ores are present in great quantities. (P.C.H.)

2548 HAFNIAN ZIRCONS. O. von Knorring and H. Hornung (Univ. of Leeds, Eng.). *Nature*, 190: 1098-9 (June 17, 1961).

Two hafnia zircons were examined in detail, one from Mtoko in Southern Rhodesia, containing 21% HfO_2 , and the other from Karibib in South-West Africa, with 31% HfO_2 . In both cases the zircons are associated with the later tantalum-rich phase of mineralization. The Mtoko zircon forms small, mauve-colored, independent crystals in the albitic zone of the pegmatite. The zircon from Karibib occurs in larger reddish-brown masses, partly intergrown with minute manganotantalite crystals and set in a matrix of lithium-bearing mica, albite, quartz, and kaolinitized feldspar. Some crystals show dominant pyramid faces, with a suppressed prism. Both zircons exhibit an intense golden-yellow fluorescence in UV light. The zircon from Karibib was found to be only weakly radioactive. Data are given concerning various properties of the two zircons. (P.C.H.)

22549 LEAD-210 IN NATURAL WATERS. Rama, Minoru Koide, and Edward D. Goldberg (Univ. of California, La Jolla). *Science*, 134: 98-9 (July 14, 1961).

The distribution of Pb^{210} which enters the oceans subsequent to its production in the atmosphere by Rn^{222} decay, shows an increase with depth in sea water. By using a simplified two-layer model of the ocean, a residence time of Pb in the upper mixed layer of less than 2 years is derived. It is suggested that the marine biosphere is responsible for the conveyance of Pb from surface to deeper waters. The distribution of Pb^{210} in the Colorado River indicated a rapid removal along the path from its origin in the feed waters to the reservoir at Lake Mead. (auth)

22550 DATING DESERT GROUND WATER. Leland Thatcher, Meyer Rubin, and Glen F. Brown (U. S. Geological Survey, Washington, D. C.). *Science*, 134: 105-6 (July 14, 1961).

Tritium in Arabian rainfall followed the trend observed in North America with peaks in 1958 and the spring of 1959. These measurements will be useful for future hydrologic studies. Water from wadi gravels averages 10 yr old. Carbon-14 measurements of deep waters indicate ages of several thousand years. (auth)

HEALTH AND SAFETY

22551 (AEET/AM/18) A PRELIMINARY SURVEY FOR AIRBORNE RADIOACTIVITY AND BACKGROUND GAMMA RADIATION AT BOMBAY. K. G. Vohra, P. Abraham, D. N. Kelkar, and M. C. Subbaramu (India. Atomic Energy Establishment, Trombay). Oct. 1960. 36p.

The data on airborne radioactivity and background intensity of gamma radiation at locations in and around the Atomic Energy Establishment Trombay is reported. The first survey carried out during February and March 1959 included 40 locations within a 6-kilometer zone around Apsara and the second survey carried out during the period January to April, 1960 included 47 locations within a 32-kilometer zone covering the City of Bombay and its environs. This survey has been completed before the start of the Canada-India Reactor to provide a record of the pre-operational environmental activity levels. It was found that the long-lived beta activity measured at the various locations in the Establishment and its environments is primarily due to the fission-products from nuclear detonations. Radon and thoron discharged from the uranium and thorium processing plants show rapid decrease with distance from the plants and beyond 1 kilometer, the levels decrease by a factor of 10 or more. The long-lived alpha activity in the air at off-site locations is primarily due to natural sources. The intensity of background radiation at off-site locations does not show large variations, and is attributed to natural sources. (auth)

22552 (ATL-D-619) SUMMARY REPORT ON THE HAZARDS OF THE UTR TEST REACTOR. ATL Job 5164. D. W. Battles and E. G. Joki (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). June 7, 1961. 82p.

Includes attachment: APPLICATION FOR CONSTRUCTION PERMIT AND FACILITY LICENSE. June 14, 1961 and letter from W. C. Wolff, dated June 14, 1961.

A detailed description of the site, facilities, and characteristics of the UTR Test Reactor and operations to be performed are presented. Also included is an evaluation of safety considerations and an analysis of potential hazards which might result from installation or operation of this reactor. Based on satisfactory operation of similar prototype reactors in the past and on a detailed hazards analysis, it was concluded that the operation of the reactor at this site will not constitute a potential hazard to property or persons in the surrounding area. The application for construction permit and facility license is included. (M.C.G.)

22553 (BRL-Memo-1341) EFFECTIVENESS OF LINING MATERIALS IN INCREASING THE BLAST RESISTANCE OF A SIMULATED OUTER CONTAINMENT VESSEL FOR A NUCLEAR REACTOR. J. W. Hanna and W. O. Ewing, Jr. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Apr. 1961. 46p.

A five-foot-diameter, spherical, thin-walled, steel shell, simulating a nuclear reactor outer containment vessel, was lined with three different shock absorbing materials and subjected to internal blast loading from Pentolite explosive charges. Strain-time histories of shell response were measured with strain gages on the shell's outer surface. Peak strains generated in the lined shells were approximately one-half those recorded with the same shell when unlined. The results suggest the feasibility of increasing the blast resistance of outer containment vessels of nuclear

reactors through the use of a suitable lining material. (auth)

22554 (HASL-109) THE ATTENUATION OF NATURAL ENVIRONMENTAL RADIATION BY AN AUTOMOBILE.

Arthur Shambon, Wayne M. Lowder, and Leonard R. Solon (New York Operations Office. Health and Safety lab., AEC). Apr. 19, 1961. 11p.

The errors introduced by making measurements of natural radiation with an ionization chamber inside an automobile are discussed and were determined over a range of background levels with varying cosmic and terrestrial components. It is concluded that the automobile attenuates the terrestrial component on the average to 0.78 ± 0.03 of its value outdoors and that the cosmic component is not materially affected. (D.L.C.)

22555 (HW-61236(Suppl.3)) PLUTONIUM RECYCLE TEST REACTOR FINAL SAFEGUARDS ANALYSIS, SUPPLEMENT 3, EFFLUENT ACTIVITY LIMITS. N. G. Wittenbrock (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 1961. Contract AT (45-1)-1350. 17p.

Refined effluent activity limits were determined for the PRTR. For both the aqueous and gaseous effluents, two limits on the concentration of radionuclides in the effluent stream were established. The upper limit is a concentration which could potentially result in undesirable contamination of the environs unless the release from the PRTR containment vessel is stopped in a few minutes. At this concentration, automatic reactor scram and containment will be executed. The lower limit is a concentration which could result in water or air contamination approaching the MPC in the environs of the PRTR, and at this concentration the reactor will be shut down with the normal procedures. (auth)

22556 (HW-SA-1962) RADIATION PROTECTION STANDARDS: THEORY AND APPLICATION. Herbert M. Parker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 24, 1960. Contract AT(45-1)-1350. 41p.

Presented at the International Symposium on Legal and Administrative Problems of Protection in the Peaceful Uses of Atomic Energy at Brussels, Belgium, September 5 to 8, 1960.

The historical background of radiation protection standards is traced. Technical and technical-administrative problems involved are identified. The current status of some radiological standards is reviewed. (B.O.G.)

22557 (HW-SA-2171) COLUMBIA RIVER CONTINUOUS MONITORING SYSTEM. T. C. Mehas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [nd]. 12p.

Presented at the Health Physics Society Meeting, Las Vegas, Nevada, June 13-16, 1961.

The environmental monitoring program at Hanford recently included an automatic facility which continuously monitors river surface γ activity and collects samples of Columbia River water for isotopic analysis. The monitoring portion of that facility is described. The equipment and methods utilized to instantaneously detect and record gamma dose rates in the micro-r/hr region, total and incremental dose, and differentiation between two broad energy bands are discussed. An alarm system which imme-

ately signals any abnormal activity or any instrument malfunction is also briefly described, as is the control circuitry of an emergency sampling system which automatically provides grab-type samples of water coincidental with abnormal activity events. (auth)

22558 (KAPL-M-HP-8) HEALTH PHYSICS QUARTERLY REPORT, JANUARY-MARCH 1961. R. J. Feinberg, comp. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-Eng-52. 28p.

Routine radiation services are listed. The audit of external and internal radiation exposures revealed no personnel radiation exposure that was greater than the acceptable standards. Radioactivity levels detected in the environs of the site indicated that the operations did not contribute adversely to the radioactivity background. A film-foil personnel dosimeter was calibrated with respect to neutron response. Nuclear safety aspects of radiation alarm systems, design of shipping and storage containers, and shipment of PTR fuel elements were reviewed and recommendations made. Nuclear emergency procedures were investigated. (M.C.G.)

22559 (MND-M3A-2496-II) PM-3A NUCLEAR POWER PLANT. HAZARDS SUMMARY REPORT. SITE DESCRIPTION AND SAFETY EVALUATION. VOLUME II. W. Haass (Martin Co. Nuclear Div., Baltimore). June 1961. Contract AT(30-1)-2700. 77p.

An evaluation of the potential hazards associated with the operation of the PM-3A nuclear power plant at the Naval Air Facility at McMurdo Sound, Antarctica was performed. A detailed analysis of the containment structure was made in terms of the peak pressure resulting from a rupture of the primary system, possible damage to the containment due to failed components behaving as missiles, and the integrity of closures, penetration, and valves. The results of the analysis indicated that the design of the containment vessels is more than adequate to confine the results of an accident with the containment subsystem. The maximum credible accident, in addition to the failure of the primary system and subsequent release of fission products from the core, postulates the remote possibility of continuous leakage of a radioactive plume from the containment vessels passing toward the personnel living quarters. The analysis of this accident indicates that the likelihood of personnel receiving excessive radiation doses is extremely remote. It is the conclusion of these evaluations, that the PM-3A nuclear power plant can be operated at the Naval Air Facility, McMurdo Sound without undue risk to the base personnel. In addition, the possibility of contaminating the surrounding environment as a result of an accident is extremely remote. (auth)

22560 (NAA-SR-Memo-6006) A SURVEY OF THE ASSUMPTIONS AND AREAS OF UNCERTAINTY IN OMR HAZARDS EVALUATION. W. P. Kunkel (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1960?] 33p.

A brief description of the organic-moderated-reactor concept is given, followed by a descriptive survey of the typical methods of OMR hazards evaluations. The methods which are presented were chosen from the literature of Atomics International studies relating to the safety analysis of organic-moderated reactor systems. Since operational experience in which significant incidents have occurred is lacking, assumptions must be made in some aspects of OMR hazard evaluations. In the absence of direct verification, these represent areas of uncertainty in varying degrees. The analytical and empirical bases for these assumptions are examined, as well as an indication of their effect on the over-all safety evaluation. (auth)

22561 (NAA-SR-Memo-6298) NUCLEAR SAFETY IN HANDLING LONG FUEL RODS. N. Ketzlach (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 18, 1961. 20p.

Suggested criteria for establishing nuclear safety parameters for long fuel rods of low U^{235} enrichment are based on minimum critical mass of U^{235} per foot length of rod. Mass limits allowed, calculated using these criteria may be several-fold larger than those calculated using minimum critical mass criteria based on either spherical or cylindrical geometry. (auth)

22562 (NP-10326) NOTES ON THE SAFE HANDLING OF URANIUM ALLOYS IN INDUSTRY. G. G. Eichholz (Canada. Dept. of Mines and Technical Surveys. Mines Branch). Jan. 20, 1961. 20p. Available as Can. Dept. Mines and Tech. Surveys, Mines Branch, Inform. Circ. IC 125. \$0.25.

Some of the physical and chemical properties of uranium metal which may have a bearing on the industrial production of uranium-containing alloys are summarized. The legal aspects of natural uranium use are reviewed and some experimental data on airborne uranium dust obtained during pilot plant tests are presented. (auth)

22563 (RISO-23) ENVIRONMENTAL RADIOACTIVITY IN DENMARK, 1960. A. Aarkrog and J. Lippert (Denmark. Atomenergikommisjonen. Forsøgsinstitut, Risø). June 1961. 51p.

Measurements were made of the background radioactivity in the Risø Area during 1960. Like previous years the measurements include determination of β -activity in a number of samples. Regular surveys were carried out on sea water, soil, air, bed-soil, eel, fresh water, precipitation, grass, sea plants, and milk. The program was extended so as to include Sr^{90} measurements on different sorts of food. Analyses were carried out on: milk, baby food, corn, and potatoes (country wide); bread, vegetables, fruit, imported food (Sealand), and total diets and drinking-water (Risø). Furthermore, Sr^{90} was determined in hare bones, fish bones, and human teeth. Finally, a determination of the total fall-out in Sealand was carried out by means of a Sr^{90} analysis on soil. (auth)

22564 (SC-4608(RR)) ENVIRONMENTAL BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, FIRST QUARTER 1961. R. E. Womelsdoff and J. E. Baker (Sandia Corp., Albuquerque, N. Mex.). May 1961. 12p.

Data are tabulated on the gross beta-gamma radioactivity of air samples collected at the Sandia Laboratory during the first quarter of 1961. (auth)

22565 (TID-12988) RADIATION SAFETY IN THE DEVELOPMENT AND USE OF NUCLEAR ENERGY FOR ROCKET PROPULSION. Wright H. Langham (Los Alamos Scientific Lab., N. Mex.). [1961?] 37p.

A vigorous safety program is being conducted concurrently with engineering development of prototype nuclear propulsion reactors, and some of its conclusions are discussed. The problem areas are delineated and reasonably sound predictions are presented of the potential radiation hazards of testing and flying a minimal performance system capable of producing 1000 Mw power for an operating cycle of 5 min. The reactor, although containing more U^{235} than an atomic bomb, could not produce a significant nuclear explosion under the most drastic accident conditions. At most, the energy release would be only ~3% of the maximum power rating. Prompt neutron and gamma radiation during operation, although lethal at short distances, will not deliver significant exposure to test and launch crews at a

distance of 1 mile. Accidental release of accumulated fission products during static testing, launch pad failure, or early mission abort would result in considerable contamination of the facilities, and extensive decontamination operations would be necessary. Impact outside the controlled area of an operated reactor, either as a result of late mission failure or re-entry from orbit, constitute a problem requiring further study. Choice of seacoast-, ocean-, and island-based launching sites, controlled re-entry and impact, and reactor burn-up or fission product boil-off in space are possibilities. General biospheric contamination from nuclear rocket operations is an insignificant problem compared to that created by nuclear weapon tests. (D.L.C.)

22566 (USNRDL-TR-435) ESTIMATING COST AND EFFECTIVENESS OF DECONTAMINATING LAND TARGETS. VOLUME I. ESTIMATING PROCEDURE AND COMPUTATIONAL TECHNIQUE. H. Lee (Naval Radiological Defense Lab., San Francisco). June 6, 1960. 71p.

The reclamation of an area that was contaminated by fallout, centers about the decontamination of the radiation hazard to tolerable levels, so that the usefulness of the area may be restored. Radiation tolerances are given in terms of exposure dosages over given periods of time; consequently decontamination must be planned with consideration of the time necessary or available for recovery, so that exposure dose limits will not be exceeded. The study determined how, by means of a dose-rate multiplier curve, a target-complex computational technique, and decontamination data, the earliest entry times may be found for any standard initial intensity and any exposure dose limit. For any entry time, the effectiveness required and the cost in terms of manpower, supplies, and accrued dose for the best suited decontamination procedure may be estimated. Included are a thorough explanation of the problem, a procedure for estimating the cost and effectiveness of decontaminating real target areas with planning guides and associated information on how to do so, and an illustration on the entire procedure in the case of a small area. (auth)

22567 (UCRL-Trans-549) SOVIET SCIENTISTS ON THE HAZARDS OF NUCLEAR ARMS TESTING. A. V. Lebedinskii, ed. Translation of Sovet. Ucheye Opasnosti Ispytaniy Yadern. Oruzhiya, 1959. 154p.

This volume is a collection of articles on the problem of harmful effects on animal and plant organisms of the emission of radioactive isotopes of Sr, C, Cs, and others which fall out from the atmosphere as a result of nuclear explosions. (W.L.H.)

22568 AIR-BORNE PARTICULATE BETA RADIOACTIVITY MEASUREMENTS OF THE NATIONAL AIR SAMPLING NETWORK-1953-1959. L. R. Setter, C. E. Zimmer, D. S. Licking, and E. C. Tabor (Robert A. Taft Sanitary Engineering Center, Cincinnati). Am. Ind. Hyg. Assoc. J., 22: 192-200 (June 1960).

Data are summarized for the period October, 1953, through December, 1959. Sampling and counting procedures are described, and the decay rates of fission products are considered. Radioactivity of particulates is presented relative to source and distribution. (auth)

22569 THE ELEMENTS OF AN EFFECTIVE COMPREHENSIVE RADIATION CONTROL PROGRAM. Hanson Blatz (New York City Office of Radiation Control). Am. Ind. Hyg. Assoc. J., 22: 209-14 (June 1961).

An evaluation of the realistic and practical aspects of protecting the general public from hazards of ionizing radiation is presented. Concentration of inspection and control efforts on the hazards with respect to their significance

in relation to dose and probability of exposure is advocated. (auth)

22570 DESIGN FEATURES AND OPERATIONAL PROCEDURES FOR THE NEW BROOKHAVEN NATIONAL LABORATORY RADIATION LAUNDRY AND RECLAMATION FACILITY. S. Pearsall and L. Gemmell (Brookhaven National Lab., Upton, N. Y.). Am. Ind. Hyg. Assoc. J., 22: 215-19 (June 1961). (BNL-5313)

Facilities and procedures for the decontamination, reclamation, or disposal of radioactively contaminated tools, equipment, and clothing are described. For safety and economy these operations are grouped in a facility with specially designed ventilation and controls under the supervision of a health physicist. (auth)

22571 PUBLIC HEALTH ASPECTS OF IONIZING RADIATION. J. R. Brown (Univ. of Toronto), D. G. Baker, W. J. Cooke, A. C. Hardman, and E. A. Watkinson. Appl. Therapeutics, 8p. (Oct. 1960).

A symposium was held to acquaint physicians with some of the fundamental principles underlying the practice of radiological health and to provide a background for further study. Topics discussed include radiation injury, the international aspects of radiation effects, the organization and development of radiation protection in Canada, and the hazards of radioactive fall-out. (C.H.)

22572 ATOMIC INDUSTRIAL FORUM SEMINAR ON AEC REGULATORY ORGANIZATION AND PROCESSES, APRIL 12, 1961. New York, Atomic Industrial Forum, Inc., 1961. 19p.

Views and comments on the regulation of nuclear facilities are presented. The form of organization and the kind of regulatory processes to assure the public that proposed reactor projects are receiving adequate safety review by the AEC and to assure application of a high order of technical competence to the governmental safety review are discussed. (N.W.R.)

22573 ASSESSMENT OF DOSE TO THE GONADS OUTSIDE DIAGNOSTIC X-RAY BEAMS. B. E. Keane, and G. Spiegler (Royal Sussex County Hospital Brighton, Eng.). Brit. J. Radiol., 34: 362-7 (June 1961).

The distribution of scatter outside the beam was investigated for 80 and 140 kv x rays. Scatter outside depends predominantly on geometry and self-absorption in the layer between the near edge of the beam and the point of reference. Correction for geometry is obtained by referring scatter to the angle subtended at the point of reference by the near edge. By correcting in this way absorption coefficients for scatter were determined. For a given object radiographs of the same contrast are shown to require the same surface dose. Since scatter per unit surface dose rises with kilovoltage, scatter per radiograph of the same contrast increases with higher kilovoltage. Only with reduced contrast may gonad dose be decreased. A method of calculating scatter doses outside the beam is described. (auth)

22574 INTEGRAL DOSE AND HIGH ENERGY RADIATION. A. Dutreix and M. Tubiana (Institut Gustave-Roussy, Villejuif, France). Brit. J. Radiol., 34: 396-7 (June 1961).

Methods are discussed which are used in calculating the integral dose delivered by Co^{60} γ rays and high-energy x rays. Data are tabulated on the integral dose received by patients and tumors under certain conditions during radiotherapy. (C.H.)

22575 REDUCTION OF RADIATION HAZARDS IN THE USE OF RADIUM AND SIMILAR SOURCES. I. RADIATION HAZARDS AND NURSING STAFF. Frank Ellis (Churchill

Hospital, Headington, Oxford). *Brit. J. Radiol.*, 34: 408-415 (July 1961).

The main hazard to the nursing staff in hospitals where radiotherapy is carried out is in connection with the use of Ra. The risk of leukemia or skin cancer to the individual is considered negligible as is the genetic risk. Assuming a gene mutation in each partner of a marriage, the probability that the same gene was changed is about 1 in 4×10^{12} . The protection and instructions to nurses working in the radium ward of the Churchill Hospital, London, is discussed. Organization and procedures carried out in the operating theater and wards are also discussed. (P.C.H.)

22576 REDUCTION OF RADIATION HAZARDS IN THE USE OF RADIUM AND SIMILAR SOURCES. II. THE CONSTRUCTION OF A REMOTE HANDLING ROOM FOR RADIOACTIVE SOURCES. R. E. Ellis (Middlesex Hospital, London). *Brit. J. Radiol.*, 34: 415-20 (July 1961).

The construction of a room suitable for handling sources, solid and liquid, in such a manner as to reduce the body dose to a low level and to eliminate the high hand and finger dose completely is described. The plan of the room consists of such items as a radium safe, storage of ovoids and uterine tubes, needle threading, cleaning and sterilization of lead pots, storage of applicators and carrying pots, and trolleys. Safety measures and cost of items are also mentioned. (P.C.H.)

22577 REDUCTION OF RADIATION HAZARDS IN THE USE OF RADIUM AND SIMILAR SOURCES. III. A GENERAL STUDY OF SOLID SOURCE HANDLING PROBLEMS. N. G. Trott and K. W. Taylor (Royal Cancer Hospital and Royal Marsden Hospital, London). *Brit. J. Radiol.*, 34: 420-8 (July 1961).

The effectiveness in controlling staff exposure from Ra and other solid radioactive sources at the Royal Cancer Hospital, London, is discussed. Protective devices are mentioned and dosage received by radium technicians is shown. Exposure of parts of the body to other staff members such as theater, ward, and isotope lab staffs is also discussed and analyzed. (P.C.H.)

22578 CONTAMINATION OF DRAIN WITH RADIOISOTOPES. T. Trnovec, K. Ďurček, E. Faithová, A. Plešková, and V. Zbořil (Klučik Inst. of Industrial Radiation Hygiene, Bratislava). *Ceskoslov. hyg.*, 5: 20-8 (1960). (In Czech)

The contamination of cast iron drain-pipes used for radioactive liquid wastes containing Sr^{90} , I^{131} , and Y^{91} without a carrier, with an appropriate carrier, and with the addition of EDTA was investigated. Y^{91} adhered most to the pipes. By means of water and acid the surface can be decontaminated. By adding the carrier and EDTA to the liquid wastes the amount of radioactive substances adhering is not substantially influenced. (auth)

22579 RADIOSTRONTIUM AND RADIOCALCIUM IN SEWAGE TREATED WITH ACTIVATED SLUDGE. T. Trnovec, K. Ďurček, E. Faithová, A. Plešková, and V. Zbořil (Klučik Inst. of Industrial Radiation Hygiene, Bratislava). *Ceskoslov. hyg.*, 5: 29-38 (1960). (In Czech)

The reduction of Sr^{90} and Ca^{45} in domestic sewage subjected to activated sludge treatment was investigated. After one trial the reduction of Sr^{90} to 93.1% and Ca^{45} to 91.3% was revealed. Oxygen content and percentage of inoculation sludge had no influence. The greatest reduction of the activity of both radioisotopes occurs if the reaction is slightly alkaline. The increase of the concentration of Ca to 365 and of Mg to 252 mg/l lead to no substantial reduction of the activity of the two radioisotopes. The metabolism of Sr^{90} and Ca^{45} did not differ substantially from the quantitative aspect of the experiments. (auth)

22580 SIGNIFICANCE OF RADIOACTIVITY DATA. Conrad P. Straub (Robert A. Taft Sanitary Engineering Center, Cincinnati). *J. Am. Water Works Assoc.*, 53: 704-13 (June 1961).

The gross radioactivity levels of surface waters are determined for the Columbia River and Ohio River Basins. Information was obtained on the effectiveness of common water treatment processes in removing radioactivity. Removal is accomplished by separating the suspended solids from the water by passing it through a membrane filter. The different kinds of suspended and dissolved radioactivity and the significance and specific parameters of the radioactivity are given. (N.W.R.)

22581 STRONTIUM-90 IN FALL-OUT AND IN MAN IN AUSTRALIA JANUARY 1959-JUNE 1960. F. J. Bryant (Atomic Energy Research Establishment, Harwell, Berks, Eng.), L. J. Dwyer, D. J. Stevens, E. W. Titterton, and J. R. Moroney. *Nature*, 190: 754-7 (May 27, 1961).

Data are presented on levels of Sr^{90} in samples of total precipitation, soil, powdered milk, cabbages, wheat grain, and sheep and human bones collected in Australia during 1959 and 1960. Mean levels of deposition of Sr^{90} in Australia were about one-fourth those in the United Kingdom and eastern United States during the same period. (C.H.)

22582 CHRONIC PROFESSIONAL RADIATION INJURY. A CASE REPORT. S. Tarusawa, T. Yanagisawa, Y. Hamatsu, and T. Mayama (Iwate Medical Coll., Morioka, Japan). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 1435-46 (1959).

A 75-year-old male physician engaged in radiology for 43 years had a history of amputation of his right middle finger, left ring finger, and right foot due to roentgen ulcers. One year before death his blood picture showed severe anemia, thrombocytopenia, and moderate leukopenia. At autopsy, the skin and the nails of the fingers and the feet were atrophic and showed roentgen ulcers. Microscopically malignant changes were not seen. The thyroid and adrenal glands showed pronounced changes due to irradiation, such as atrophy of follicles, hyperplasia of connective tissue, and struma nodosa parenchymatosa with a typical hyperplasia of its epithelial cells in the thyroid gland, atrophy of glomerular zone, hypertrophy of external fascicular zone, over-growth of juxtamedullary zone, and hyperplasia of medullary cells in the adrenal glands. Though the patient died from uremia resulting from prostate hypertrophy, it could not be denied that the cause was various changes of tissues due to irradiation. (Abstr. Japan Med., 1: No. 8, 1961)

22583 STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT AND HUMAN SUBJECTS DUE TO NUCLEAR EXPLOSIONS. H. Iwasaki (Osaka City Univ.). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 1447-58 (1959).

The radioactivity of rain and dust collected on greased paper was measured. It was observed to be increasing year after year. Sr^{90} concentration of human bones was measured in 56 samples during the period from January 1957 to the end of 1958. It was evident that the Sr^{90} concentration in the bone was high in infants from 1 month to 10 years of age. (Absts. Japan. Med., 1: No. 7, 1960.)

22584 MEASUREMENTS OF LEAKAGE AND SCATTERED RADIATION FROM A TELECOBALT UNIT. K. Yano (Matsue Red Cross Hospital, Japan). *Nisseki Igaku*, 12: 602-5 (1959).

Leakage radiation from the Toshiba, Mod. RR 103-D telecobalt unit showed a maximum of 3.2 mr/hr at 1 m from the source at the off position; it was highest at the front right side of the bomb. Scattered radiation at the

operating room measured less than 0.15 mr/hr. Exposure dose for the operators was less than 5 mr/day, a value far below the maximum permissible dose. (Absts. Japan. Med., 1: No. 7, 1960.)

22585 DOSIMETRY OF HUMAN CELL CULTURES IRRADIATED AT THE INTERFACE IN PLASTIC AND IN GLASS DISHES. S. L. Hood and Grace Norris (Charles F. Kettering Foundation, Yellow Springs, Ohio). Radiation Research, 14: 705-12 (June 1961).

Human cell cultures grown on plastic and glass surfaces were irradiated with 76-kv x rays. Single-cell colony survival curves indicated absorbed dose differences caused by scatter from dish materials. The correction factor combining scatter and conversion from roentgen to rad units for cells irradiated on Pyrex glass is 1.42 ± 0.07 and for polyvinyl chloride plastic is 1.72 ± 0.28 , both compared to polystyrene plastic which is equivalent to soft tissue or medium. (auth)

22586 RADIOACTIVATION BY THE (γ, γ) -REACTION. VII. APPLICATION OF THE (γ, γ) -REACTION TO THE γ -RAY DOSIMETRY; STUDIES ON THE RELATIVE METHOD BY THE USE OF 10 kc COBALT-60 γ -RAY SOURCE. Nagao Ikeda, Kenji Yoshihara, and Kazuo Shimada (Tokyo Univ. of Education and Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 8: 17-23 (Mar. 1959). (In Japanese)

The application of the $\text{In}^{115}(\gamma, \gamma)\text{In}^{115\text{m}}$ reaction to gamma dosimetry is studied by using a 10-kc cobalt-60 source. Indium foils (2 cm \times 3 cm) were mounted at definite positions around the source. The dose rate at each position was measured with a Roentgen rate meter and a chemical dosimeter and compared with induced radioactivities. It was found that these values were, in general, proportional. The values obtained by the chemical dosimetric method, however, seem to be affected by the scattering effect at positions near the wall of the cave, and the proportionality is not good in this region. (γ, γ) -dosimetry is convenient for the measurement of high dose rates near large sources and gives good results for gamma rays over 1.04 Mev. (N.W.R.)

22587 DOSIMETRY OF THE FAST NEUTRON EXPOSURE BY THE USE OF THE $^{32}\text{S}(\text{n}, \text{p})^{32}\text{P}$ REACTION. Minoru Fujita, Jun Akaishi, and Hozumu Yamamoto (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 9: 102-7 (Sept. 1960). (In Japanese)

Further studies were made on the burning procedure, and an extraction procedure was developed. Both procedures are described. Both were found to be favorable for routine methods. (P.C.H.)

22588 GONADAL EXPOSURE INCIDENT TO ROENTGEN THERAPY. Gustave Kaplan, Carl Collica, and Sidney Rubinfeld (Veterans Administration Hospital, New York). Radiology, 76: 877-80 (June 1961).

Attempts should be made to minimize as much as possible exposure to the gonads during roentgen therapy for benign conditions. Complete elimination of gonadal exposure is apparently impossible because of the phenomenon of internal scatter within the long axis of the body. Covering the gonads with lead above is insufficient; minimal exposure is obtained only with coverage above and below. The optimum thickness of lead for protection is 0.5 mm. Curves are presented which permit direct readings of gonadal exposure as functions of distance to the gonads, treatment-field size, and half-value layer. (auth)

22589 GONADAL DOSAGE IN PEDIATRIC RADIO-THERAPY. John L. Gwinn, David C. Gastineau, and John

A. Campbell (Indiana Univ. Medical Center, Indianapolis). Radiology, 76: 881-4 (June 1961).

Phantoms of children aged six months, six years, and twelve years were constructed and irradiated under conditions simulating actual therapeutic procedures. The gonadal dosages received were measured by Victoreen No. 362 pocket dosimeters, which were checked against a 250-mr Victoreen chamber. The dosages measured are recorded in a series of tables. More accurate measurements will have to await further refinement of the instrumentation. (auth)

22590 RADIONUCLIDE FRACTIONATION IN BOMB DEBRIS. E. C. Freiling (U. S. Naval Radiological Defense Lab., San Francisco). Science, 133: 1991-8 (June 23, 1961).

The composition of fractionated samples from high-yield surface bursts is correlated logarithmically. The slopes obtained for the various mass chains (except for molybdenum-99) are relatively insensitive to the environment and are empirically related to precursor volatility. Zirconium-95, cerium-144, uranium-237, and neptunium-239 do not fractionate grossly from one another, nor does molybdenum-99 fractionate from these radionuclides when coral is in the environment; cesium-137 does not fractionate grossly from strontium-89. The fact that the slopes of the correlation curve for two radionuclides are identical within their respective margins of error cannot be interpreted as meaning that no fractionation was observed. Small degrees of fractionation between similarly behaving radionuclides are best tested by plotting the ratio of their f values against the fractionation index. Even the data with the poorest fit fall wide of the correlation lines only by a factor of about 2. In all cases except that of the deep-water surface burst, the cloud sample was found to be rich in strontium-89. (auth)

22591 EVALUATION OF THE ORIGINS OF STRONTIUM-90 CONTAINED IN WHEAT PLANT. Ryushi Ichikawa, Michiko Abe, and Masako Eto (National Inst. of Radiological Sciences, Chiba City, Japan). Science, 133: 2017-8 (June 23, 1961).

Twenty percent of the strontium-90 in wheat flour in 1959 was due to root absorption, 30% was due to floral absorption from soil particles attached to the ear, and 50% was due to current fall-out. In 1960, 35% was due to root absorption, 50% to floral absorption from soil, and 15% to current fall-out. (auth)

22592 STUDY OF CONTAMINATION BY FISSION PRODUCTS AND ITS REMOVAL. I. THE DIFFERENCE OF RADIOACTIVE CONTAMINATION AND ITS REMOVAL IN VARIOUS KINDS OF SOIL. J. Takanaka (Hiroshima Univ.). Suido Kyokai Zasshi, [No.] 301, 73 (1959).

Using various kinds of fission product activity, the efficiency of removal from the soil by ion exchange resin was studied. Though results showed slight differences according to differences of radioactivity, there was no difference in the specific character of the decontamination agents. (Absts. Japan. Med., 1: No. 7, 1960.)

22593 HAEMATOLOGICAL AND BIOCHEMICAL EXAMINATIONS OF X-RAY TECHNICIANS. T. Niyama (Tokyo Jikeikai Medical Coll.). Tokyo Jikeikai Ikadagaku Zasshi, 73: 707 (1959).

One hundred and four x-ray technicians were examined in December 1955, July, September, and December 1956, and in March 1957. In 75 cases hyperchromic anemia and lymphocytosis were found, while serum magnesium showed a tendency to increase. It is concluded that x-ray technicians should be examined hematologically at least 4 times a year. (Abstr. Japan. Med., 1: No. 1, 1960)

22594 THE PACKAGING, TRANSPORT AND RELATED HANDLING OF RADIOACTIVE MATERIALS. F. R. Farmer (International Atomic Energy Agency, Vienna). Review Series No. 12. Developments in the Peaceful Applications of Nuclear Energy. 1961. 64p. (In English, French, and Russian). (STI/PUB/15/12)

Requirements for the safe handling and transport of radioactive and fissile materials are explored. The review suggests a framework within which the development of national and international traffic may proceed safely. In particular, aspects of surface and contour radiation levels, quantity of radioactive material, specifications of and acceptance tests for containers, as well as problems associated with transport of fissile material are considered.. (auth)

22595 THERAPEUTIC DOSE DISTRIBUTIONS WITH HIGH-ENERGY RADIATION. SURVEY OF EXISTING DATA AND REPORT OF A PANEL ON PHYSICAL DATA FOR DOSE DISTRIBUTIONS WITH HIGH-ENERGY RADIATION HELD AT VIENNA, 7-11 NOVEMBER 1960. (International Atomic Energy Agency, Vienna). 1961. 72p.

A survey was made of existing data for dose distributions and equipment with high-energy radiation in radiotherapy. The questionnaire sent out consists of three parts: single field isodose curves, isodose curves for multiple and moving fields, and equipment in use or planned. The replies to the questionnaire from various

countries are summarized. The report of a panel group on the subject is also discussed, and the questionnaire is included. (P.C.H.)

22596 WATER POLLUTION RESEARCH 1960. The Report of the Water Pollution Research Board with the Report of the Director of the Water Pollution Research Laboratory. (Gt. Brit. Dept. of Scientific and Industrial Research). 1961. 127p.

From the water pollution research program of Great Britain in 1960, a new method was developed in which a radioactive tracer, gold-198, is used to study mixing in an anaerobic digester. The method is used in the dewatering of digested sludge. An experiment on sewage dewatering is described. (N.W.R.)

22597 TKANEVAYA DOZA NEITRONOV. (Neutron Dosimetry in Tissue). M. I. Shal'nov. Moscow, Atomizdat, 1960. 218p.

Available published data and results of experiments are reviewed. Analytical and experimental data on neutron absorption from narrow and wide beams of slow, fast, and superfast neutrons are discussed, and the basic problems of biological effects and permissible doses are analyzed. The interpolation method for evaluating relative biological effects according to linear energy losses and dosage limits in humans are studied. Methods for neutron dosimetry are described and evaluated. 208 references. (R.V.J.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

22598 (AD-251636) USE OF IONIZING RADIATIONS TO PRESERVE FRUITS AND VEGETABLES. Report No. 5 (Progress), May 1, 1959–August 5, 1959. Ray McBrien (Denver and Rio Grande Western Railroad Co., Denver). Contract QMR&E (NATICK) No. 58. 2p.

Market-grade Shasta strawberries, and fresh Bing and Lambert cherries were studied for extended shelf life and organoleptic evaluation. Shelf life extension studies were made for cannery peas, after blanching for 6 min at 190°F, and for fresh peas. (B.O.G.)

22599 (AD-251683) RADIATION STERILIZATION OF COCOA POWDERS. Report No. 3 (Progress), November 18, 1959–May 17, 1960. C. J. McCombs (Nestle Co., Inc., White Plains, N. Y.). Contract QMR&E (NATICK) No. 114. 2p.

A summary is given of the results and conclusions of a study of the effects of radiation doses of 0.1×10^6 and 0.5×10^6 rads on the blooming characteristics and general quality of chocolate coatings. (B.O.G.)

22600 (AD-251705) RESEARCH STUDY ON THE INTRAMUSCULAR FAT AND ASSOCIATED CHARACTERISTICS IN PORK. Report No. 1 (Progress), December 15, 1959–July 15, 1960. R. W. Bray (Wisconsin Univ., Madison). Contract DA-19-129-QM-1514. 3p.

A summary is given of the work done in making organoleptic evaluations of the radiation effects on pork loins chosen according to the visual evidence of intramuscular fat content. (B.O.G.)

22601 (DPR/INF/260) ISOTOPE TECHNIQUES FOR NUCLEAR ENGINEERS. J. L. Putman (United Kingdom Atomic Energy Authority, London). Apr. 1961. 11p.

Ways in which isotope techniques may serve or are serving in the development of nuclear power are given. The application of tracer techniques to the engineering problems of flow and translocation are described. The use of radioisotopes for determination of bulk flow patterns, liquid flow measurements, liquid leak detection, gas flow and ventilation studies, gas leak detection, wear and transfer studies, autoradiography in metallurgy, chemical analyses, fluorescence spectrometry, thickness gages, level gages, density gages, and flow inspection are discussed. (M.C.G.)

22602 (NYO-9142) UTILIZATION OF RADIOACTIVE ISOTOPES IN COAL PROCESS RESEARCH. Eighth Quarterly Technical Status Report Covering Period February 1, 1961 to April 30, 1961. P. M. Yavorsky and E. Gorin (Consolidation Coal Co. Research and Development Div., Library, Penna.). May 1, 1961. Contract No. AT-(30-1)-2350. 20p.

A new method of labeling organic compounds with tritium is being developed and initial results are encouraging. The tritiating reagent, $\text{Th}_2\text{PO}_4 \cdot \text{BF}_3$, is used to exchange tritium for hydrogen. The experimental procedure is very simple. Tagging model compounds has demonstrated that aromatic hydrogen and hydrogen on tertiary carbon atoms are easily exchange-labeled whereas paraffinic hydrogen does not exchange. This method is more rapid, less involved, and much less destructive to the parent tracer than the radiation induced self-labeling method for hydrocarbon labeling. Practically no highly tagged side products are generated and radio-chemically pure tracers are immediately pro-

duced. Any desired specific activity in the tracers can be produced. The level is primarily controlled by the amount of tritium used in making the tritiating reagent. Usable tracers are easily made in a day. (auth)

22603 (PAN-227/XVI) TRASIROVANIE PERE-MESHCHENIYA SHIKHTY VO VRASHCHAYUSCSHIKHSYA PECHAKH DLYA PROIZVODSTVA SUPERTOMASINA NA ZAVODE "BONARKA" V KRAKOVE. (Tracer-Tests of Material Transport in Rotary Kilns Used for Production of Sodium Thermophosphate at the "Bonarka" Plant in Krakow). K. Akerman, P. M. Goffman, A. Pochinailo, Ya. Oglaza, E. Griglik, Z. Pletti, and E. Bereski (Polish Academy of Sciences. Inst. of Nuclear Research, Krakow). May 1961. 17p.

A study was made of rotary kilns used for the production of sodium pyrophosphate in the "Bonarka" Plant in Krakow. The analysis was carried out to determine the possibility of adopting the kilns for the production of sodium pyrophosphate using small amounts of soda. The material transport rate was determined by labeling the charge with Na^{24} as sodium metasilicate. It was concluded from the radiometric measurements and measurements of temperatures of gases and of material in the kilns that there are favorable conditions in the kiln 75 m in length for the start of industrial experiments on the production of sodium pyrophosphate using small amounts of soda. In the last two kilns, 50 m in length, the conditions of decomposition of apatite in a charge with small amounts of soda can be obtained by the intensification of heating of the kilns and by the improvement of heat exchange between a solid phase and gases, i.e. by means of increasing of the retention time of the charge in the high temperature zone. (auth)

22604 (CEA-tr-A-836) ETUDE SUR LES EAUX A L'AIDE D'ELEMENTS MARQUES. (Study of Water Using Labeled Elements). K. Sauerwein. Translated into French from Deutsche Gewasserkd. Mitteilgn., Sonderheft, 1958. 25p. (includes original, 6p.).

The radioisotope labeling method for water research is compared with the dye-labeling and salt-labeling methods and discussed. The isotope used should be selected on the basis of half life, radiation energy, chemical form, and specific activity. Procedures are given for determining currents in a water-course, finding distribution of water in a water-course, flow and distribution of water of a stream emptying into the reservoir of a dam. (T.R.H.)

22605 (NP-tr-649) A KRYPTON-85 LIGHT SOURCE. P. J. Nowacki, A. Kazimerski, E. Strychalski, and J. Rydel. Translated by J. J. Cornish (U.K.A.E.A., Atomic Energy Research Establishment) from Polska Akad. Nauk Inst. Badán Jadrowych, No. 175/111, (Sept. 1960). 12p.

An atomic light source is described which uses β -radiation from krypton-85 for exciting luminous emission from a luminophor consisting of a mixture of copper-activated zinc and cadmium sulfides. For the lamp which was prepared, a brightness of about 3000 microlamberts was obtained on the surface of the 55 mm-diameter window with ~ 800 mc of krypton-85. The method of filling the lamp is also described. (auth)

22606 TREATMENT OF PEARS WITH X-RAY AND ELECTRON RADIATION. H. Hansen and T. Grünwald

(Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atompraxis, 7: 213-16 (June 1961). (In German)

Three sorts of autumn pears were given various doses of radiation. A high-current x-ray emitter (120 kev) and an electron accelerator (1 Mev) served as radiation sources. Changes in the maturation process of the pears after irradiation were determined on the basis of certain typical maturation characteristics. Here a marked acceleration of ripening was found in the range from 20 to 50 kr, while hardly any difference was found after 100 kr in comparison with the non-irradiated controls. There was a marked retardation of ripening after 200 kr, and even more after 400 kr, so that the pears remained in saleable condition eight days longer than usual. No essential difference was found between x-ray and electron irradiation in regard to their influence on maturation. No deviations from normal taste were found, not even in the pears which had received 400 kr. This indicates a commercially applicable method of controlling the course of maturation in pears. (auth)

22607 MEASUREMENTS OF AIR MOVEMENTS IN A HOUSE USING RADIOACTIVE TRACER GAS. A. H. Howland, D. E. Kimber, and R. F. Littlejohn (British Coal Utilisation Research Assn., Leatherhead, Eng.). J. Inst. Heating Ventilating Engrs. (London), 28: 57-71 (May 1960).

Experiments are described in which a radioactive gas (Kr^{85}) was used to measure the air movements occurring in a typical, detached, suburban house. The air change rates which took place in single rooms with their doors shut and heating by either central heating radiators or open fires were first measured. These tests showed that excessive air changes occurred with the ordinary open fire, but that these were reduced to a level normally regarded as desirable by using a freestanding convector fire with restricted throat. When the rooms were heated by hot water radiators, excessive air changes still occurred unless the chimney was sealed or a freestanding convector fire with its throat restrictor at its maximum closure was installed. With either of these conditions, however, rates of air change were near the optimum for good ventilation. The effect of leaving the doors of all the rooms open with all the windows shut was also investigated. It was found that when the downstairs rooms only were heated very large air flows took place from these rooms to the upper story, and circulation rates of up to 16,000 cu ft/hr from each of the downstairs rooms were found. By means of temperature measurements, it was shown that these air movements caused large heat transfers to the bedrooms if the bedroom doors were left open. If, however, the bedroom doors were shut or if an upstairs landing window was left open, very little warming of the bedrooms took place, and considerable heat losses occurred through the open window. An investi-

gation was also made into the behavior of a forced-circulation ducted warm-air system, which was of the type in which ducting was not provided from each room for the return air. It was shown that with the doors closed much of the warm air put into the rooms escaped through the windows even when these were closed. (auth)

22608 TREATMENT OF MEATS WITH IONISING RADIATIONS. VII. EFFECT OF LOW TEMPERATURES DURING IRRADIATION. B. Coleby, M. Ingram, H. J. Shepherd, M. J. Thornley, and G. M. Wilson (Low Temperature Research Station, Cambridge, Eng.). J. Sci. Food Agr., 12: 483-90 (June 1961).

Raw pork and beef were irradiated with 2 Mev electrons at controlled temperatures from 18 to -196° . Appearance, odor, and flavor were assessed by a taste panel, the destruction of glutathione was estimated chemically, and the extent of the survival of the bacterium determined. In each case, a relation to the temperature of irradiation was observed similar to that previously recorded for thiamine. There was little effect between 18 and 0° ; but a rapidly increasing protection from 0 to -20° , with a smaller increase down to -196° . Experiments in the range 0 to -10° , in which destruction of glutathione was the criterion, indicated that protection began when ice separated from the tissue. (auth)

22609 METHODS USED FOR INTRODUCING RADIOACTIVE SULFUR INTO METALS. V. N. Shikhov (Ural Polytechnic Inst., USSR). Zavodskaya Lab., 27: 165-6 (1961). (In Russian)

Introduction of the radioactive S^{35} with a half-life of 87.1 days into alloys for the purpose of studying the mechanism of the desulfurization reaction, presents a serious personnel hazard. Under industrial conditions, the activity of the sulfur may reach values of 1 curie or more, especially if autoradiographic methods are used. In order to ensure the introduction of the correct amount of active material into the alloy in a safe manner, a solution of Na_2S^{35} was diluted with a chemically identical solution of inactive Na_2S until the desired activity level is reached, then precipitating FeS with the stoichiometric amount of $FeCl_2$, and adding the filtered, washed, and dried precipitate to the batch. Difficulties have been encountered in view of the oxidizability of the precipitate and the potential formation of radioactive H_2S . The S^{35} was introduced into the alloy composition by means of active Co and Ni sulfides. The hazard presented was evaluated by heating the Fe containing S^{35} to $1580^{\circ}C$ while passing air over it, and absorbing the SO_2 and the SO_3 liberated by a 5% $KClO_3$ solution. The volatility of the S was found to be proportional to its concentration in the alloy. Co and Ni sulfides were the least volatile while FeS was about twice and elementary sulfur was about 7 to 8 times more volatile. (TTT)

ISOTOPE SEPARATION

22610 (DP-558) ELECTROLYTIC SEPARATION FACTORS FOR HYDROGEN ISOTOPES. Richard R. Foster, Douglas H. Purcell, and J. Allen Wheat (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1961. Contract AT(07-2)-1. 16p.

The radiation associated with tritium does not affect the separation factors for the hydrogen isotopes in the electrolytic decomposition of water. Instantaneous separation factors computed from the partial electrolysis of a 170- μ l sample of liquid were 5.6 for protium-deuterium, 1.9 for deuterium-tritium, and 10.4 for protium-tritium. (auth)

22611 (AEC-tr-4061(p.30-40)) THE PRODUCTION OF PROTIUM AND PROTIUM OXIDE. L. M. Yakimenko, A. I. Shatenshtein, M. A. Rabinovich, E. A. Yakovleva, Z. M. Borisova, and E. N. Zvyagintseva. Translated from Zhur. Neorg. Khim., 2: 2507-12(1957).

A continuously working apparatus was constructed for producing H_2 with a D_2 content of less than 0.00001 at.%. In this apparatus, one electrolysis step and 10 isotopic exchange steps are used. Half a liter of zero standard water per day can be obtained by reacting the H_2 with atmospheric O_2 and may be used to determine the D_2 content and Dole correction for natural waters. (D.L.C.)

22612 (AEC-tr-4061(p.300-6)) USE OF RADIOACTIVE SULFUR FOR STUDYING THE PROCESS OF CONCENTRATING RARE ISOTOPES OF SULFUR BY THE METHOD OF CHEMICAL EXCHANGE. I. A. Korshunov and A. P. Batalov. Translated from Zhur. Neorg. Khim., 2: 2676-9(1957).

The radioactive isotope S^{35} was used to study the concentration of a heavy sulfur isotope S^* by the $S^*O_2 + HSO_3^- = SO_2 + HS^*O_3^-$ exchange in a countercurrent column. The effects of flow rate and concentration of the working solution on the concentration factors were studied. The maximum concentration factor obtained was 1.203, and from the assumed value of 1.031 for the equilibrium constant, the number of theoretical plates were calculated to be 6. (D.L.C.)

22613 (CEA-tr-A-769) PROCÉDÉ POUR DIMINUER LA CONCENTRATION DE DEUTÉRIUM DANS L'EAU RÉSIDUELLE D'UN CATALYSEUR PULVÉRENT, APRÈS FILTRATION D'UNE SUSPENSION DE CATALYSEUR SUR LE GATEAU DU FILTRE. (Process for Lowering the Concentration of Deuterium in the Residual Water of a Powdered Catalyst After Filtration of a Catalyst Suspension on the Filter Cake). F. Uhde. Translated into French by R. Carbonnier from German Patent 1054,969, (1959). 9p.

A process is described for lowering the D concentration in residual water adhering to filtered catalyst in an isotope separation process. (T.R.H.)

22614 (CEA-tr-A-863) PRÉPARATION ET UTILISATION DU LITHIUM ENRICHÉ EN 6Li ET DU LITHIUM ENRICHÉ EN 7Li . (Preparation and Utilization of Lithium Enriched in Li^6 and Lithium Enriched in Li^7). A. Klemm. Translated into French from Z. Elektrochem., 58: 609-10 (1954). 12p.

A method for the preparation of lithium enriched in Li^6 and Li^7 , based on the relative mobilities of the two ions in a fused electrolyte, is described. The ions can be collected either on an electrode or at the interface separating $LiCl$ from another chloride. The advantages and disadvantages of each method of accumulation are described. A typical apparatus for the electrolytic separation of lithium isotopes

is sketched. Uses of lithium enriched in either isotope are reviewed. (J.S.R.)

22615 (CEA-tr-A-943) INSTALLATION INDUSTRIELLE POUR LA PRODUCTION D'EAU LOURDE À BASSE TEMPÉRATURE. (Industrial Installation for Production of Heavy Water at Low Temperatures). J. Hännny. Translated into French from Schweiz. Arch., angew. Wiss. u. Tech., 26: 115-28(1960). 47p.

An industrial installation for the production of heavy water, which is in service at the chemical plants of the S. A. Emser Werke at Domat/Ems, is described. The primary material is natural water, which, passing through three successive electrolysis stages, is enriched in deuterium in the proportion of 1:7. The hydrogen-deuterium gaseous mixture obtained by electrolysis of the water is cooled to $-250^\circ C$ and then introduced liquefied into a rectification column of the Kuhn system where the processes of exchange causes at $23^\circ K$ a deuterium enrichment of 1:400. This new product is then oxidized by combustion and sent into a second Kuhn column where the D_2O concentration reaches 99.8%. The gaseous hydrogen cycle of the Ems installation is equipped with dry piston compressors and high-velocity expansion turbines. It is the only hydrogen liquefaction installation in the world using only expansion turbines with no recourse to cooling by liquid nitrogen. The insulation of all heat exchangers, turbines, and control apparatus is obtained by the use of high vacuum. (tr-auth)

22616 (NP-tr-647) PRODUCTION AND USE OF HEAVY WATER. L. Kùchler. Translated by F. Hudswell (U.K.A.E.A. Atomic Energy Research Establishment) from Chem.-Ingr.-Tech., 32: 773-81(1960). 41p.

The physical properties of light and heavy hydrogen and the use of heavy water as a reactor moderator are discussed. A comparison of the raw materials for the production of heavy water is presented. The following methods of production are discussed: electrolytic separation of hydrogen, distillation, and exchange processes. Industrial plants for the production of heavy water by means of hydrogen distillation are described. The cost of heavy water and the economics of the processes are also discussed. Comparison of the various methods of production and discussions of their advantages and disadvantages indicated that the distillation of liquid hydrogen and the exchange processes are best suited to the industrial production of heavy water. (M.C.G.)

22617 THE PROCEDURAL BASIS OF ISOTOPE SEPARATION BY MEANS OF HOT-COLD EXCHANGE [PART] II. A. Schmidt (Osterreichische Stickstoffwerke AG, Linz/Donau, Austria). Atompraxis, 7: 220-2(June 1961). (In German)

Part I of the study presented the two phases used for the isotope exchange in an idealized form, without considering the solubility of the gas in the liquid or the vapor pressure of the latter. The present article gives two methods for correcting the calculations by including solubility and vapor pressure. (auth)

22618 ISOTOPIC SEPARATION FACTOR FOR THE SYSTEM POTASSIUM AMALGAM-AQUEOUS POTASSIUM HYDROXIDE. H. H. Garretson and J. S. Drury (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 34: 1957-8(June 1961).

The isotopic fractionation of potassium amalgam and aqueous KOH was measured at room temperature. The single-stage separation factor was 1.006 ± 0.002 (95% C. I.). (auth)

619 SEPARATION FACTORS IN MULTICOMPONENT MIXTURES OF ISOTOPES. Alfred Narten (Columbia Univ., New York). *J. Chem. Phys.*, 34: 2198-9 (June 1961). The discussion is restricted to vapor-liquid equilibria; in the case of general isotopic exchange equilibria, equilibrium constants must be used instead of vapor pressures. The single-stage separation factor for the distribution of the isotopic species i and k between the gas and liquid phase for a given temperature, $\alpha(i/k) = P^0(i)/P^0(k)$. In the j -component system, all separation factors, except $j-1$, can be derived according to $\alpha(i/k) = \alpha(1/k)/\alpha(1/i)$. An equation is derived that gives the dependence of the effective separation factor on the individual separation factors as defined by the concentration of the individual isotopic species in the mixture. Discussion is also given on the rule of the geometric mean, and systems in which it holds or does not hold are examined. (P.C.H.)

620 SEPARATION OF THE ISOTOPES HT AND D₂ BY ADSORPTION AT LOW TEMPERATURES. Anthony Katorski, J. G. Eberhart, and David White (Ohio State Univ., Columbus). *J. Phys. Chem.*, 34: 2189-90 (June 1961). The predictions of the theory concerning the separation of isotopes of the same mass are presented. Since HT is more volatile than D₂ at a given temperature, a similar phenomenon should occur on adsorption of the two at low temperatures. Thus a method for the separation of these species is provided. A value which gives a zero-point energy of D₂ equal to 2.0 kcal/mole is used to calculate the isotope separation factor. The separation factors at 20°K are $(ab)^2 = 0.25$, $S = 1.6$ and $(ab)^2 = 0.50$, $S = 1.9$. (P.C.H.)

621 CORRELATION BETWEEN CATHODIC OVERVOLTAGE AND THE SEPARATION EFFICIENCY FOR HYDROGEN ISOTOPES. J. Brun, W. Gundersen, and T. Lassen. *Kgl. Norske Videnskab. Selskabs, Forh.*, 68: 68-73 (1959). (In English) Estimations of separation factors for some metals other

than Hg, carried out on the basis of comparative measurements of deuterium and hydrogen overvoltage at the metals in acid and alkaline solutions, are reported. Results are compared with some direct separation factor determinations. Some preliminary experiments on the effect of alloying components on the separation efficiency of some cathode metals are also reported. Only the binary alloy systems Ag-Pb, Cu-Bi, Pb-Sn, and Cu-Ni are included in the preliminary measurements. (P.C.H.)

22622 TEORIYA RAZDELENIYA IZOTOPOV V KOLONNAKH. (Theory of Isotope Separation in Columns). A. M. Rozen. Moscow, Atomizdat, 1960. 438p.

An analysis is made of various methods of isotope separation: distillation, exchange, thermal diffusion, mass diffusion, and centrifugation. The processes are studied through the general concepts of regular mass transmission in physico-chemical hydrodynamics. The concepts of mass transmission coefficients, concentration, and the height of the transition unit are used in the analyses of thermal and mass diffusion. Such an approach reduces the unique characteristics of various processes to the concentration coefficient value, which in turn demonstrates the dependence of the transition unit height on the hydrodynamics and physico-chemical properties of the admixtures and the apparatus geometry. The general column and cascade calculation methods are examined, and the methods and aspects of engineering diffusion processes are correlated with the general separation theory. The theory and the calculation methods for columns (rectangular cascades) were further developed, and general separation theory was used for selecting the optimum parameters. The optimum conditions are determined for two-phase separation (distillation and exchange). Relatively simple formulas are developed for calculating the approach to equilibrium in various columns. A similarity is developed for non-stationary processes and electric circuits, allowing column and cascade kinetics to be modeled. Various separation devices are described. 217 references. (R.V.J.)

MATHEMATICS AND COMPUTERS

22623 (AEFW-M-77) SAKURA—A TWO-MEDIUM THERMAL NEUTRON SPECTRUM PROGRAMME. D. C. Bindon (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1960. 34p.

A computer program is described for computing the thermal neutron spectra and effective cross-sections in a reactor system of two media by the method of H. Takahashi. The program was prepared and tested for use with the Ferranti Mercury computer. (auth)

22624 (CF-61-6-59) RCS, AN IBM-7090 PROGRAM FOR CALCULATION OF CROSS SECTIONS FROM RESONANCE PARAMETERS. M. E. Tsagaris and C. A. Preskitt (Oak Ridge National Lab., Tenn.). June 15, 1961. 12p.

An IBM-7090 code, RCS, was programmed to be run under control of the monitor system. This code calculates cross sections from resonance parameters, and the output from a calculation lists the σ_a , σ_f , σ_s , and σ_T microscopic cross sections for any number of given energies. (auth)

22625 (DASA-1232) THREE-DIMENSIONAL RAY TRACE COMPUTER PROGRAM FOR ELECTROMAGNETIC WAVE PROPAGATION STUDIES. Walter F. Dudziak (General Electric Co. Technical Military Planning Operation, Santa Barbara, Calif.). May 1, 1961. Contract DA 49-146-XZ-038. 179p. (RM 61TMP-32)

A computer program is described for IBM-704/7090 computers accepting FORTRAN. The necessary modifications for use on the two computers are simple and self-evident. The computer program permits the computation of detailed ray patterns portraying the spatial distribution of rays emitted from a transmitter whose geographic coordinates with respect to the center of the earth are known. The program deals with the solution of the differential equations, given by Hamiltonian optics, for ray paths in non-isotropic, three-dimensionally nonhomogeneous media whose complex phase refractive index is given by the Appleton-Hartree formula. This is to be considered as a first attempt in presenting an account of the current status of the development of this program. Presented also are sample calculations as well as some results that were obtained by using the program. (auth)

22626 (HW-62902) SIMULATION OF A RECIRCULATING, STIRRED CHEMICAL DISSOLVER ON AN ANALOG COMPUTER. G. R. Taylor (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1961. Contract AT(45-1)-1350. 35p.

The simulation of a recirculating chemical dissolver on a general purpose analog computer is described. The fluid in the dissolver is assumed to be completely mixed and plug flow is assumed in the storage reservoir. With these assumptions, the reservoir can be simulated by a transport lag or time delay. A method of implicitly introducing the transport lag is presented. Results are given for variations in the parameters of the chemical reaction rate, the ratio of reservoir volume to dissolver volume, and the circulation time through the dissolver. (auth)

22627 (KAPL-M-DIG-TD-14) FLT, AN IBM-704 DIGITAL COMPUTER PROGRAM FOR THE CALCULATION OF MULTI-LOOP FLOW TRANSIENTS. G. H. Bornmann, R. D. Burgess, B. L. Strain, and R. B. Taylor (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 1961. Contract W-31-109-ENG-52. 128p.

The FLT program is an IBM-704 digital computer pro-

gram developed specifically for the calculation of flow transients occurring in a multi-loop flow system closed by a common flow path. Such transients may arise from pumping faults such as pump motor open circuiting, loss of excitation, and mechanical failure, or from normal pump startup and pump switching. The present program is capable of calculating complete or sequential loss of flow accidents arising from the first three pumping faults listed. The program is based on a multi-loop model of up to three inertially symmetric flow loops with one canned rotor, variable frequency, induction motor driven pump per loop having a separate motor power supply. Each loop also has a check valve representation, and a separately controlled isolation valve making it possible to initially or subsequently use any combination of flow loops. For the above transient flow conditions, specified as computer input for any loop combination and pump failure stagger time, the program will calculate flow and pump speed as a function of time for each flow loop. Subsequent versions of FLT will include other pumping faults as well as startup and switching transients. FLT is a FORTRAN program requiring an IBM-704 digital computer of 8,000 word minimum core storage. (auth)

22628 (KAPL-M-MAK-1) PTA PRESSURIZER PROGRAM TRANSIENT ANALYSIS. M. A. Ketchum (Knolls Atomic Power Lab., Schenectady, N. Y.). May 16, 1961. Contract W-31-109-Eng-52. 30p.

PTA is a computer program written in FORTRAN for the Philco-2000. It was designed to study the transient performance of a pressurizer model as specified for a natural, forced or mixed convection power plant system. The overall pressure of the primary coolant loops is calculated as a function of the surge, heater output, and the spray effect. The program may be run open loop on a main coolant temperature function or used as a part of TANK, the transient system code which includes other components such as the reactor, coolant loops, pumps, and secondary system. (auth)

22629 (KAPL-M-WBL-3) EXPLICIT—A DIGITAL COMPUTER PROGRAM FOR PULSED NEUTRON DATA REDUCTION. W. B. Leng (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 14, 1961. Contract W-31-109-Eng-52. 26p.

It is desirable in a pulsed neutron experiment to fit a set of counter data obtained at equal increments of time to a single exponential function. In the EXPLICIT code, this is accomplished by fitting the logarithm of the corrected counts to a linear function of time using a weighted least squares method. The original counter data are corrected for background and counting losses. The analysis is performed separately with a pre-burst and post-burst background. The data are analyzed over a time interval which is selected by various criteria. The initial time of this interval can be arbitrarily chosen provided a counting loss criteria are satisfied. The analysis continues until the statistical and signal to background criteria are not satisfied. Less than three data channels remaining after satisfaction of all criteria will cause the program to be discarded with appropriate comments. (auth)

22630 (LA-2535) LAGRANGIAN DIFFERENCE APPROXIMATIONS FOR FLUID DYNAMICS. Jacob E. Fromm (Los Alamos Scientific Lab., N. Mex.). Mar. 1961. Contract W-7405-ENG-36. 70p.

Various procedures are given for writing explicit difference approximations to the one-dimensional Lagrangian hydrodynamics equations. Computational comparisons were made among systems of equations with timing modifications. These comparisons led to experimentally superior differencing forms. Stability analyses of these difference forms showed the reasons for the superiority of one form over another. Of greater importance, the stability criteria obtained showed the function of an artificially introduced diffusion term required in the treatment given to shocks. The stability criterion in each case involved the familiar Courant condition and a term which corresponds to the stability criterion of the diffusion equation. Upper limits to the magnitude of the coefficient of the diffusion term were established as a function of Courant number. While lower limits were also indicated, they required modification when shocks were involved. Alternate differencing schemes were considered in which the previously-used total energy calculation was replaced by an internal energy calculation. It is shown that care must be taken that the kinetic and internal energies are expressible in terms of local quantities. That is, in addition to the equations being conservative in a gross sense, they must also be locally conservative. This is necessary in order that the energy condition of the Rankine-Hugoniot equations be satisfied when shocks arise. Finally discussion is given to errors resulting from the replacement of shocks by a shock layer, that is, errors connected with the artificially inserted diffusion term. These errors were manifested in distortions of profiles at material discontinuities through which shocks passed and in refractions associated with such occurrences. The errors in turn effected stability in the vicinity of the material discontinuities. (auth)

2631 (UCRL-9498) LINEAR PROGRAMMING APPLIED TO LINEAR DIFFERENTIAL EQUATIONS. Jonathan D. Young (California. Univ., Berkeley, Lawrence Radiation Lab.). Jan. 17, 1961. Contract W-7405-eng-48. 3p.

The numerical solution of linear differential equations by linear programming is described. (D.L.C.)

2632 (WAPD-T-1205) THE ANALOG NON-LINEAR SYSTEM ANALYZER. William H. Alliston (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 1960. Contract AT-(11-1)-GEN-14. 23p.

A device intended to aid in the analysis of non-linear control systems by providing a means of measuring the fundamental component in the output of a system, both in amplitude and phase, for a wide range of frequencies and input amplitudes is described. Two modes of operation are provided, continuous and discontinuous. Standard analog computer components were used throughout, with the exception of the controller which timed the integration. The operation of the analyzer may be extended to plot harmonic response of the system as a function of the fundamental-frequency input. Methods used by the sine-cosine wave generator to generate two sine waves which are 90° apart in phase, over a frequency range of 0.01 to 20 cps, are discussed. Results of preliminary operating tests were entirely satisfactory. (M.C.G.)

2633 (NP-tr-634) THE M-2 HIGH-SPEED COMPUTER. M. A. Kartsev, T. M. Aleksandridi, V. D. Gayazev, G. I. Tanetov, L. S. Legezo, Yu. A. Lavrenyuk, I. I. Shchurov, N. P. Brunsentsov, and V. P. Kuznetsova. Translation of "Bystrodeystviyushchaya Vychislitel'naya mashina M-2" (a publication of the State Publishing House of Theoretical and Technical Literature, Moscow, 1957). 3p.

The compact high-speed M-2 computer is described. It has 1676 tubes and performs an average of 2000 operations per second. The basic arithmetic, internal storage, control, and external storage units of the machine are described, with the purpose, principle of operation, logical design, and general characteristics given for each. The general principles of the machine's construction, its system of number representation and programming, and the layout of the basic elements of its circuits are outlined. (M.C.G.)

22634 n-DIFFUSION. J. R. Philip. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Australian J. Phys., 14: No. 1, 1-13 (Mar. 1961).

Transfer processes in which an entity is transferred down a gradient of a concentration-like quantity satisfy the relation $q = -A \cdot \nabla B$, with q the flux density, A dependent on time, concentration and position, and B a function of the concentration gradient, $\nabla \theta$. In ordinary diffusion $B = \nabla \theta$. The more general transfer process, designated n -diffusion, for which $B = |\nabla \theta|^{n-1} \nabla \theta$ ($n > 0$) is considered. The simplest unsteady one-dimensional problem is studied, of n -diffusion (with A constant) into a semi-infinite region. The results are extended to the related problem in the (doubly) infinite region. Solutions are found in terms of the incomplete beta-function, though for certain values of n solutions are expressible in terms of elementary functions. Infinite "tails" (analogous to that in 1-diffusion) occur for $0 < n < 1$, while the concentration profiles are finite for $n > 1$. Distance of penetration into the region and cumulated flux vary as $(\text{time})^{1/(n+1)}$. (auth)

22635 SYSTEM HANDLING OF FUNCTIONAL OPERATORS. Lionello Lombardi (Univ. of California, Los Angeles). J. Assoc. Computing Machinery, 8: No. 2, 168-85 (Apr. 1961).

Systems for handling free operators in order to bridge the wide gap existing between the way scientists state problems or mathematical models and the program to which these problems or models must be reduced to be accepted by the compilers or computers of current use are discussed. A system which makes use of charts and symbols for the expansion of the problems, rather than on a translation of the source problems is presented. This system may be used for handling undefined expressions, namely, expressions that do not define a real function of a finite set of real variables such as expressions representing operators on function spaces. (N.W.R.)

22636 AN APPLICATION OF THE RECIPROCITY THEOREM TO THE ACCELERATION OF MONTE CARLO CALCULATIONS. C. W. Maynard (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 10, 97-101 (June 1961).

In solving two-dimensional one-energy transport problems, it is often necessary to utilize Monte Carlo calculations in situations where this technique converges very slowly. In problems with regionwise constant sources where the required result is the flux at a point or an integral of the flux over a region or surface, the reciprocity theorem can be used to determine an auxiliary problem which yields the same information and in many cases improves the statistics appreciably. The relations required in choosing the auxiliary problem are derived. The required integrals and statistical errors are stated in terms of the results for the auxiliary problem. Examples are given to illustrate the application of these ideas to a flux peaking situation and to the absorption in a small region. The extension of this procedure to energy-dependent cases is discussed briefly. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

22637 (NP-10279) PREPARATION OF ULTRAFINE HIGH PURITY REFRACTORY METAL POWDERS. Final Report. Philip J. Clough (National Research Corp., Cambridge, Mass.). Apr. 5, 1961. Contract NOas 60-6003-c. 16p.

The development of an electron gun for evaporating refractory metals for the preparation of submicron powders is described. A small quantity of submicron molybdenum powder was produced with the gun. The mechanical properties of pressed ultrafine aluminum powder are reported in an appendix. (D.B.C.)

22638 (TID-11045) [PRODUCTION OF BERYLLIUM HYDROXIDE AND PREPARATION OF SINTER COMPACTS]. Quarterly Report for July 1, 1960 through September 30, 1960. (Beryllium Corp., Reading, Penna.). Contract AT-(11-1)-465. 16p.

Activities in a program for production of beryllium hydroxide by sodium beryllate hydrolysis starting with beryllium hydroxide filter cake are summarized. Experiments were conducted to determine the optimum relative quantities of $\text{Be}(\text{OH})_2$ and NaOH required to produce sodium beryllate under various conditions. Results and conclusions based on the experiments are given and details of a typical beryllate experiment are presented. In other work, modifications of techniques are described for preparation of sinter compacts comprising beryl ore, sodium fluosilicate, soda ash, and water. It was found that predensification of the sinter mix powder is required for the formation of dense, spheroidal pellets in rotary tubes. Data and discussion related to an 11 in. diameter pilot plant rotary tube are included. (J.R.D.)

22639 (WADD-TR-60-795(Pt.I)) EXTREME TEMPERATURE RANGE ORGANIC COOLANTS PART I. -80°F TO 400°F TEMPERATURE RANGE FLUIDS. Dale A. Barsness (Wright Air Development Div. Materials Central, Wright-Patterson AFB, Ohio). Dec. 1960. 30p.

A review of the status of extreme temperature range (ETR) coolants for electronic equipment is presented. The fluids considered for use over a -80 to $+400^\circ\text{F}$ temperature range are described and fall into the following classes of compounds: amines, chlorofluorocarbon oils, fluorochemicals, silicones, silicate esters, and siloxanes. Results show that the silicone fluids comply most closely to the physical properties required for ETR electronic coolants. It was observed that they are the only group of materials that possess high boiling points and thermal stabilities above the 400°F bulk operational temperature, and still display reasonably low viscosity values within the extreme temperature range. The electrical properties of these materials are also very desirable. The reported data include the viscosity-temperature relation, vapor pressure-temperature properties, electrical characteristics, thermal properties, and flammability characteristics. (auth)

22640 (NP-tr-615) LIQUID METAL RESEARCH IN THE INSTITUTE OF NUCLEAR RESEARCH IN 1956-58. M. Pasek. Translated from *Jaderná energie*, 5: 363-7 (1959). 20p.

The results are given of research work in liquid metals, done in the Institute of Nuclear Research of the Czechoslovak Academy of Sciences in 1956-1958. The results are focused mainly on tests of pumping and circulating of liquid metals in cooling systems, on studies of heat transfer, and

on the measurements of flow and viscosity of liquid metals. (auth)

22641 A DETERMINATION OF THIN OXIDE FILM THICKNESS BY INTEGRATED INTENSITY MEASUREMENTS. Bernard Borie and C. J. Sparks (Oak Ridge National Lab., Tenn.). *Acta Cryst.*, 14: 569-70 (June 10, 1961). (In English)

The thicknesses of thin single-crystal oxide films are determined by integrated intensity measurements in absolute units. The method is illustrated with measurements of Cu_2O films grown on copper single crystals. Thicknesses determined from two different Bragg maxima agree well with each other, and are reasonably consistent with the thicknesses determined from the line shapes. (auth)

22642 SUPERGRAPH. B. C. Baines (Hawker Siddeley Nuclear Power Co., Ltd., Slough, Bucks, Eng.). *Atom-praxis*, 7: 128-31 (Apr. 1961). (In English)

After introducing the problems of high density graphite, a short description of the furfuryl alcohol impregnation process is given. In general the mechanical properties of the basic material are improved by a factor of 1.5 to 2 or more, the porosity is reduced by a factor of about 4, and the density increased by about 7%. (auth)

22643 INVESTIGATION OF THE PHYSICO-CHEMICAL INTERACTIONS OF RARE-EARTH METALS WITH IRON AND STEEL. E. M. Savitskii, V. F. Terekhova, and V. A. Tskalov. Redkozemel. Elementy v Stalyakh i Splavakh, Trudy Soveshchaniya, 31-49 (1959).

The interaction of rare-earth metals, such as La and Ce, with S, O, Si, and C of steel and the effect of Ce and La on the mechanical properties of Fe were studied. The Fe-La system, with up to 2 wt% La, was studied by microscopic, electronmicroscopic, and mechanical methods. It is established that small additions of rare-earth metals (0.2 to 0.5%) refine considerably the structure of iron and steel. Rare-earth metals are strong deoxidizers which cause the finely-dispersed distribution of oxide impurities. The addition of 0.2 to 0.5% rare-earth metals to steel containing S > 0.1% causes considerable desulfurization. At a S content < 0.02 to 0.03%, desulfurization is not observed. The presence of < 0.2% Si in the steel does not reduce the refining effect of Ce. The rare-earth metals introduced into the steel in an amount of 0.9 to 1.5%, interact with C, forming carbides, and reduce considerably the perlite content in the steel. The addition of 0.1 to 0.2% rare-earth metals causes higher strength, ductility and δ_5 of steel. An increase of the rare-earth metal content from 0 to > 3% reduces the mechanical properties of iron and steel due to the formation of brittle intermetallic compounds. At a La content of > 0.4 to 0.5 wt%, a second phase is observed in the Fe-La system. Solubility of La in γ -Fe is greater than in α -Fe. A considerable improvement of physico-mechanical properties of Fe-Al alloys was observed when rare-earth metals were introduced in an amount of up to 5 wt%. (OTS)

22644 INVESTIGATION OF THE PROCESS OF FORMATION OF "BLACK NICKEL" DEPOSITS. A. G. Samartsev and N. V. Andreeva (Baikov Inst. of Metallurgy, Leningrad). *Zhur. Fiz. Khim.*, 35: 893-9 (Apr. 1961). (In Russian)

The polarization curve method was applied in a study of the formation of <<black nickel>> deposits. The chemical composition of the deposits was elucidated. Black nickel is a complex formation in which a relatively small amount

nickel is scattered in the body of secondary electrolysis products deposited on the cathode together with the metal. The major secondary products are zinc hydroxide and sulfide, thin layers of which should be electroconductive. It is proposed that the black color of the deposits is due not to the presence of dark colored compounds but to the structural particularities of the deposits. (auth)

2645 METALLURGIYA REDKOZEMEL'NYKH METALLOV TORIYA I URANA. (Metallurgy of Thorium and Radium Rare Metals). A. N. Zelikman. Moscow, State Scientific Technological Publishers of Literature on Ferrous and Non-Ferrous Metallurgy, 1960. 380p.

Processes for extracting rare earths, thorium and uranium from various types of rocks are reviewed and methods of treating, separating, and producing chemical compounds are analyzed. Descriptions are given of the physico-chemical properties of the metals and their applications. The origin and mineral content of various types of rocks are discussed. Preparations of pure metallic thorium and uranium are discussed. An extensive bibliography is included. (V.J.)

2646 PROCESS OF COATING GRAPHITE WITH NIOBIUM-TITANIUM CARBIDE. Frank A. Halden, W. D. Hildreth, and F. M. Hruz (to U. S. Atomic Energy Commission). U. S. Patent 2,991,192. July 4, 1961.

A process of coating graphite with niobium-titanium carbide is described. It is found that the addition of more than ten percent by weight of titanium to niobium results in much greater wetting of the graphite by the niobium and much more adherent coating. The preferred embodiment comprises contacting the graphite with a powdered alloy or mixture, degassing simultaneously the powder and the graphite, and then heating them to a high temperature to cause melting, wetting, spreading, and carburization of the niobium-titanium powder.

2647 THORIUM DISPERSION IN BISMUTH. J. S. Gwynne (to U. S. Atomic Energy Commission). U. S. Patent 2,991,237. July 4, 1961.

The growth of thorium bismuthide particles, which are formed when thorium is suspended in liquid bismuth, is inhibited when the liquid metal suspension is being flowed through a reactor and through a heat exchanger in sequence. This involves the addition of as little as 1 part by weight of fluorine to 100 parts of thorium. This addition is sufficient to inhibit particle growth and agglomeration.

Corrosion

2648 (ANL-6232) STUDIES OF THE HYDROGEN DAMAGE MECHANISM IN THE CORROSION OF ZIRCONIUM. R. D. Misch (Argonne National Lab., Ill.). May 1961. Contract W-31-109-eng-38. 20p.

It is difficult to evaluate the effect of cathodic elements on the corrosion of zirconium in water because of the low corrosion rate. By the addition of 0.5 wt % of titanium, however, the oxidation of zirconium to ZrO_2 in 350°C water is increased, permitting a better relative evaluation of the effect of different cathodic elements. Alloys containing 0.1 wt % iron, nickel, copper or platinum in addition to 0.5 wt % titanium had lower corrosion rates than the 0.5 wt % titanium alloy alone. The largest improvement was derived from nickel and the least from platinum. The nickel alloy had the disadvantage of absorbing 90% of the corrosion hydrogen while the platinum alloy absorbed a negligible corrosion resistance and hydrogen absorption. In the presence of oxidizing agents ($CuSO_4$, $CdSO_4$, I_2) the absorption of hydrogen diminished and corrosion resistance showed a

further improvement. These results were interpreted to indicate that hydrogen may be damaging within the oxide as well as at the metal-oxide interface. Zirconium compacts, sintered with conducting dispersants, were inferior in corrosion resistance to arc-melted zirconium. The cathodes were beneficial only by comparison with zirconium controls sintered under the same conditions. In complex alloys, cathodes may arise in a variety of ways and the corrosion resistance of the intermetallics may be of importance. (auth)

22649 (ANL-6259) ELECTRICAL RESISTANCE STUDIES OF ANODIC AND CORROSION OXIDE FILMS FORMED ON ZIRCONIUM. R. D. Misch (Argonne National Lab., Ill.). May 1961. Contract W-31-109-eng-38.

Oxide films were produced on Zr and Zr-Ti alloys by anodizing and by exposure to O_2 and H_2O at high temperatures. The electrical resistances of the films were measured in air at room temperature and in vacuum at temperatures up to 290°C. At room temperature, all films were insulators, although anodic films had the higher resistivities. Upon heating corrosion films to 185 and 290°C, they became semiconducting. Corrosion films on Zr alloys containing 0.05 to 0.50 wt % Ti had relatively constant resistances, although the corrosion rates increased rapidly in this range and the films showed potential differences. For Zr alloys containing 10 to 95 wt % Ti, the film resistances decrease with Ti content and potential differences were absent in most cases. The results indicate the measurements of the electrical properties of the corrosion films should be made during corrosion. (D.L.C.)

22650 (KAPL-M-EJC-6) A STATISTICAL STUDY OF ZIRCALOY-2 WATER AND STEAM AUTOCLAVE CORROSION TESTS. E. J. Callahan and M. A. Powers (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 15, 1961. Contract W-31-109-ENG-52. 33p.

The weight gains and oxide appearance ratings of Zircaloy-2 material were analyzed statistically to determine population differences and differences between four testing conditions: three and fourteen day water tests (680°F, 2708 psi), and three and fourteen day steam tests (750°F, 1500 psi). The distributions of the weight gains for the four testing conditions were considered random samples from the true distribution of weight gains for acceptable Zircaloy-2 as a large number of specimens from a large number of different tests and ingots were included in each distribution. The means and tolerance limits of these distributions were compared with existing specification limits to determine if these limits were realistic in view of current corrosion testing results. It was found that in a fourteen day steam test that a linear relationship exists between the amount of white corrosion product (oxide rating) and the weight gain, the more stringent criterion for acceptable Zircaloy-2 is the oxide appearance of the corrosion product, not the weight gain, and weight gain limits for three day steam and fourteen day water tests could be raised. (auth)

22651 (NAA-SR-Memo-6064) CALCIUM NITRIDE IN SODIUM. Theron L. MacKay (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 20, 1961. 8p.

Below 300°C, nitrogen did not react with Ca dissolved in sodium. In the range 355 to 720°C, dissolved Ca reacted with nitrogen in the cover gas, forming a relatively insoluble compound, probably Ca_3N_2 . Calcium nitride precipitation continued until the reactant present in the least amount was exhausted. Saturation solubility of calcium nitride in sodium appears to be between 100 and 200 ppm, and does not appear to be a function of temperature in the

range of these experiments. It is possible that the numbers represent particulate Ca_3N_2 suspended in sodium. The solubility of calcium in sodium as reported was verified. (auth)

22652 (TID-12987) CORROSION INVESTIGATION OF INOR-8 DURING DISSOLUTION OF ZrO_2 WITH HF. F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). May 31, 1961. 22p.

Experiments were made to determine the durability of INOR-8, Hastelloy N, and two types of welds under hydro-fluorination conditions in molten LiF-NaF at 700°C while ZrO_2 is being dissolved. ZrO_2 is readily dissolved in fluorides with HF at rates varying from 1 to 6 $\text{mg}/\text{cm}^2/\text{hr}$. Corrosion of INOR-8 was severe, especially at the interface. The data indicate that areas near the sparging gas, interface, and crevices can be expected to corrode rapidly at rates up to 100 mils/month. The nature of INOR-8 corrosion is similar to that of Hastelloy N. No selective attack was observed in the welds. No effect of ZrO_2 dissolution on the corrosion was observed. (D.L.C.)

22653 (AEC-tr-4656) THE OXIDATION OF CERIUM AND LANTHANUM. Jean Loriers. Translated from *Compt. rend.*, 229: 547-9(1949). 3p.

A comparison was made of the oxidation of cerium and lanthanum. Some rectangular samples of these two metals having one surface area of about 1 cm^2 were treated at a rising temperature, under atmospheric pressure, in dry oxygen. The curve of oxidation of lanthanum as a function of time was found to be comparable to those of metals forming protective oxide coats, while the speed of oxidation of cerium at a given temperature remained constant with time indicating that this metal belongs to the class of those which are not protected by their oxides. (M.C.G.)

22654 (CEA-tr-X-276) INFLUENCE DU TELLURE SUR LA RESISTANCE A L'OXYDATION DES ALLIAGES DE ZIRCONIUM. (Influence of Tellurium on the Oxidation Resistance of Zirconium Alloys). T. Sano, S. Imoto, et. al. Translated into French from *Nippon Kinzoku Gakkaishi*, 23: 486-9(1959). 23p.

In a consideration of the various factors which can affect the concentration and mobility of ionic oxygen voids, on which the oxidation resistance of zirconium depends, it was predicted that the incorporation of a hexavalent element would offer the best chance for the improvement of the oxidation resistance of zirconium. Tellurium was chosen as the hexavalent element because the dimension factor is the most favorable. After preparation of Zr-Te alloy samples, they were tested for resistance to oxidation in a heated state, the weight increase from oxidation being measured with a quartz spring balance. The oxidation tests at 850°C in oxygen emphasize that Zr alloy with 160 ppm Te does not show peeling even after 6000 min, whereas peeling of pure Zr is evident after 2600 min. The oxidation resistance tests at 750°C in ambient air show the particularly remarkable efficiency of Te in improving this resistance. In effect, peeling in the alloy with 160 ppm Te is not produced even after 5000 min, but peeling of pure Zr has started after 1300 min. The weight increase from oxidation of the alloy at the point of peeling is of the order of a tenth of that of pure Zr. The results obtained during the experimental study have shown that the oxidation velocity of zirconium alloys is controlled by the atomic valence, the ionization potential, and the ionic radius of the incorporated element. (tr-auth)

22655 (NP-tr-665) PROBLEMS OF CORRODING STRUCTURAL MATERIALS BY LIQUID METALS. Alois Dvorak. Translated from *Jaderná energie*, 6: No. 6/5, 155-62(1960). 20p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 16968.

22656 HIGH TEMPERATURE AQUEOUS CORROSION OF ALUMINUM-URANIUM AND ALUMINUM-SILICON-URANIUM ALLOYS. H. C. Bowen and R. L. Dillon (General Electric Co., Hanford Labs., Richland, Wash.). *Corrosion*, 17: No. 7, 9-11(July 1961). (In English)

Tests in 350°C deionized water of Al-U alloys were made in an effort to predict behavior in this environment of Al-Pu alloys. Al-Si-U alloys also were tested under the same conditions. Samples prepared by casting, of wrought material, and of castings by the cryolite process were compared. Tests showed no samples with significantly distorted jackets when there were minor openings in the jackets. Aluminum alloys with less than 6 wt.% uranium were unsatisfactory. Al-Si alloys containing up to 6 wt.% uranium were satisfactory. Some as-cast Al-U alloys were preferable to Al-Si. (auth)

22657 THE COMPARATIVE ROLES OF OXYGEN AND INHIBITORS IN THE PASSIVATION OF IRON. III. THE CHROMATE ION. G. H. Cartledge (Oak Ridge National Lab., Tenn.). *J. Phys. Chem.*, 65: 1009-15(June 1961).

Polarization studies were extended to the chromate ion in oxygen or helium, for the purpose of determining the relative contributions of the two oxidants to the total cathodic current on passive iron. It was found that the cathodic reduction of chromate ion on passive iron is similar to that of the pertechnetate ion in being slow, relative to the reduction of oxygen. It was found that the chromate ion does not accelerate reduction processes on the electrode. It was found also that the fully passivated surface apparently contains a reducible component other than the passivating film itself. It is not easily destroyed by substitution of helium or carbon monoxide for oxygen, though a limited amount of electrochemical reduction suffices for its elimination without activation of the electrode. (auth)

22658 INFLUENCE OF STEAM CORROSION ON PROPERTIES OF REACTOR MATERIAL ZIRCALOY-2. E. Bodmer (Gebrüder Sulzer AG, Winterthur, Switzerland). *Schweiz. Arch. angew. Wiss. u. Tech.*, 27: 114-20(Mar. 1961). (In German)

Some long-term corrosion tests on Zircaloy-2, at 430°C and at 260° to 360°C show that the brittleness was greatly increased. The mechanical properties of annealed test pieces in the β phase were greatly diminished. The routine utilization of Zircaloy-2 is limited to temperatures below 400°C . (tr-auth)

22659 EFFECT OF SOME INHIBITORS ON THE CORROSION CRACKING OF STEEL 1X18N9 IN 42% MgCl_2 SOLUTION. N. I. Podobayev, S. A. Balezin, and V. V. Romanov (Baikov Inst. of Metallurgy, Moscow). *Zhur. Fiz. Khim.*, 35: 748-53(Apr. 1961). (In Russian)

Steel 1X18N9 welded and non-welded and at initial stretching loads above the yield value, is protected from corrosion cracking in boiling 42% MgCl_2 solution acidified by HCl (0.19 by volume, s. g. 1.19) with the aid of inhibitor PB-5 in 0.2% concentrations. The addition of 1% BA-12 inhibitor + 0.04% KI to the boiling 42% MgCl_2 solution has a similar effect. The inhibitors PB-8 and BA-12 + KI retard the corrosion cracking process of the metal in the above solution but do not inhibit it completely. Divalent and trivalent iron salts (0.3 mole/l) cause complete loss of protective action of PB-5 but do not affect that of BA-12. The protective action of cathodic polarization and of inhibitors in the corrosion cracking of steel 1X18N9 in 42% MgCl_2 solution is additive. Anodic polarization lowers the protective action of inhibitors but does not eliminate it completely. (auth)

2660 CORROSION OF CADMIUM-ANTIMONY ALLOYS IN SULFURIC ACID. I. M. Bokhovkin (Archangel Inst. of Forestry, USSR). Zhur. Fiz. Khim., 35: 789-92 (Apr. 1961). (In Russian)

The rate of corrosion of Cd-Sb alloys in sulfuric acid, depending upon the concentration of the latter, was determined. Alloys containing up to 52% Sb were found to have rate curves exhibiting a maximum. Further increase in Sb leads to a fall in the corrosion rate and to disappearance of the maximum. A diagram showing the dependence of the corrosion rate upon the alloy composition is presented. The sharp fall in corrosion rate beginning with 52% Cd and higher is due to the formation of CdSb and to the more positive potential of Sb. An explanation is given for the increase in corrosion with Sb contents up to 30%. This is due to facilitation of the cathodic process in the presence of the more electropositive Sb. The inhibiting properties of furfural in the corrosion of Cd-Sb alloys in H_2SO_4 were investigated. Furfural almost completely suppresses the corrosion of these alloys in H_2SO_4 . With dioxane the corrosion rate is lowered by one half. Corrosion resistant boundaries of the alloys were established. They correspond to 50% Sb and 0% Cd. (auth)

Fabrication

2661 (ABMA-DSN-TN-14-60) FLAME SPRAYED CERAMIC COATINGS. V. F. Seitzinger and E. F. Sharpe (Army Ballistic Missile Agency, Redstone Arsenal, Ala.). June 13, 1960. 27p.

Information on the nature, properties, and general characteristics of flame sprayed ceramic coatings is presented. After a discussion of general principles of the method, various techniques are described. This is followed by examples of applications in missiles. (auth)

2662 (AMC-TR-7-532a(I)) MACHINING OF REFRACTORY MATERIALS. Phase I Technical Engineering Report, November 7, 1960-January 7, 1961. L. J. Nowinski, W. P. Koster, N. Zlatin, and M. Field (Metcut Research Associates Inc., Cincinnati). Jan. 1961. Contract F33(600)-42349. 151p. (AD-250201)

An industrial and literature survey was conducted to study problems in machining refractory materials for aerospace applications. Mo, Nb, Ta, and W and their alloys are treated in detail. The major machining problems at present are associated with Mo and W. Information is needed on machining René 41 and ultrahigh-strength alloys in the hardness range R_c 54 to 60. A machining research program is proposed. (D.L.C.)

2663 (AMC-TR-7-775(III)) COLUMBIUM AND COLUMBIUM ALLOY EXTRUSION PROGRAM. PHASE III. DEVELOPMENT OF THE EXTRUSION OPERATION. Interim Report III [for] February 28, 1961 to May 28, 1961. S. Clark and A. W. Dana, Jr. (Du Pont de Nemours & Co. Pigments Dept., Wilmington, Del.). May 28, 1961. Contract AF 33(600)40700. 45p.

Initial extrusions of T sections of the Nb-10Ti-10Mo alloy are described. Satisfactory dimensional tolerances were obtained for a five-foot extruded section. However, the extruded surfaces contained imperfections and did not meet surface smoothness requirements. (auth)

2664 (AMC-TR-7-782(III)) THE DEVELOPMENT OF OPTIMUM MANUFACTURING METHODS FOR COLUMBIUM ALLOY FORGINGS. Interim Technical Progress Report, September 15, 1960-December 15, 1960. John B. Guernsey and R. O. Carson (Crucible Steel Co. of America,

Midland Research Lab., Penna.). Dec. 1960. Contract AF33(600)-39942. 31p. (AD-254118)

Electrode manufacture and melting practices are partially established for the four forging alloys. Successful forging of 200-pound F48 ingots was performed as a part of the associated Nb sheet contract. (auth)

22665 (AMC-TR-7-784(III)) THE DEVELOPMENT OF OPTIMUM MANUFACTURING METHODS FOR COLUMBIUM ALLOY SHEET. Interim Technical Progress Report, September 15, 1960-December 15, 1960. John B. Guernsey and R. O. Carson (Crucible Steel Co. of America, Midland Research Lab., Penna.). Dec. 1960. Contract AF33(600)-39942. 33p. (AD-251556).

Nb-15W-5Mo-1Zr, were made by the previously selected electron-beam first-melt and vacuum-arc second-melt procedure. Preliminary evaluation of both ingots shows they are of high quality. Ingot breakdown studies on small diameter billets show that cast F48 can be successfully worked by forging. The technique developed was used to successfully upset forge one of the eight-inch diameter, 200-pound ingots approximately 40%. (auth)

22666 (MAB-172-M) REPORT ON REFRACTORY METALS SHEET ROLLING PANEL ACTIVITIES. (National Research Council. Materials Advisory Board). May 22, 1961. 29p. Contract DA-36-039-sc-76436.

A discussion is given of the activities of a program created to accelerate efforts to produce high-quality, consistent sheet material from refractory metals and their alloys. An outline is presented of property requirements for acceptable alloys of molybdenum, niobium, tantalum, and tungsten. To date, two fabricable molybdenum alloys have been selected, and a sheet rolling program was initiated for unalloyed tungsten. A selection is being made for a niobium alloy. A description is given of sub-panels formed to assist in the selection of the acceptable alloys. (B.O.G.)

22667 (NASA-TN-D-864) EXPERIMENTAL METHOD OF PRODUCING POROUS TUNGSTEN FOR ION ROCKET ENGINES. Neal T. Saunders (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). June 1961. 23p.

The results of a preliminary program to investigate the effects of particle size and sintering temperature on the porosity of tungsten ionizers are presented. Tungsten powders of 1, 10, and 20 microns average particle size were sintered at 2250 to 2900°F. Results of metallographic examination and nitrogen-flow tests on disks representing various combinations of particle size and sintering temperature are discussed. A method of producing thin porous tungsten platelets with a known porosity is reported. Platelets manufactured by this method have successfully operated in an experimental ion engine. (auth)

22668 (NDA-2162-3) CARBIDE FUEL DEVELOPMENT. Progress Report Period, February 1, 1961 to April 30, 1961. A. Strasser (United Nuclear Corp., White Plains, N. Y.) and K. Taylor (Carborundum Co., Niagara Falls, N. Y.). June 1, 1961. Contract AT(30-1)-2303. 16p.

Fuel Fabrication and Evaluation. Nearly stoichiometric, low nitrogen-content UC was synthesized in the plutonium glove box atmosphere. PuC and PuC-UC preparation studies were initiated by the oxide-carbon reaction. UC with nickel additions lowered required sintering temperatures, improved density over control straight UC samples, but did not improve densities over those obtained previously with UC. Microprobe analysis of niobium and $2\frac{1}{4}$ Cr-1 Mo compatibility samples tested 4,000 hr at 820°C, showed no uranium penetration. Irradiation Test. The W1-1 capsule containing two clad UC specimens continued operation to

11,000 MW-d/ton by the end of April. The W1-2 capsule was inserted in WTR, but had to be removed after a short time because of a radioactive gas leak. Plutonium Facilities. The facility at The Carborundum Company started operation with plutonium in March. Modifications and maintenance continue to be required and are being completed with minimum effect on experimental work schedules. The major modifications of the facility at NDA, the once-through nitrogen and helium systems, were completed and initial operation is satisfactory. A performance test was initiated prior to operations with plutonium. Design and construction of equipment for the furnace box are in progress. (auth)

22669 (NP-10223) DEVELOP PROCESS FOR AND ARC CAST 25 TO 50 POUND INGOTS OF TIN REDUCED MOLYBDENUM. Progress Report for the Period March 31—April 30, 1961. Allen D. Abraham (Oregon Metallurgical Corp., Albany). Contract NORD-18124. 14p.

One 100-lb molybdenum ingot was melted and preliminary testing was conducted. The metal exhibited room-temperature ductility, had extremely good grain-boundary strength, and small specimens could be forged and rolled to sheet directly from the as-cast material. The forgings exhibited good metal flow and excellent quality. The most striking feature of the metal was the excellent grain-boundary strength which presumably accounted for the room-temperature ductility and increased ultimate strength. (auth)

22670 (NP-10243) HARD PARTICLE STRENGTHENING OF REFRACTORY METALS FOR HIGH TEMPERATURE USE THROUGH INTERNAL OXIDATION. Progress Report No. 2. March 1, 1961—April 30, 1961. A. S. Buford, K. M. Zwilsky, and N. J. Grant (New England Materials Lab., Inc., Medford, Mass.). May 29, 1961. Contract N0W-61-0316-c. 6p.

Mechanical properties of internally oxidized Mo-1.5% Ti extruded in a Dynapak were investigated. Powders of -325 mesh obtained from machining and ball milling a Mo-1.5% Ti ingot were consolidated into six billets for further Dynapak extrusions. (auth)

22671 (NP-10308) THE MANUFACTURE OF Ti-7AL-12Zr SHEETS. Bi-monthly Report X, February 28, 1961 to 30, 1961. J. K. Dietzel and S. R. Seagle (Reactive Metals, Inc., Niles, Ohio). June 1961. Contract NOA(s) 59-6229-c. 9p.

A method of flattening 0.125-in. sheet between 2-in.-thick steel plates was developed. Preliminary data from the annealing-temperature survey showed that the ductility of annealed 0.040-in. sheet after thermal exposure was 13.6%, and after creep exposure, 11.6%. The first 0.020-in. sheet was finished hot rolled in production and tested. The results showed that 0.012-in. had to be removed from the sheet to achieve satisfactory properties after thermal exposure. One-half of the scheduled number of production-size 0.063-in. sheets was rolled to final gage. (auth)

22672 (WADD-TR-60-404) A STUDY OF THE EFFECT OF ELECTRON BEAM MELTING ON COMPOUNDS AND METALS. R. L. Martin, S. R. Seagle, and O. Berteau (Reactive Metals, Inc., Niles, Ohio). July 14, 1960. Contract AF 33(616)-5603. 79p.

A study was made on the effect of electron beam melting on boron, boron-carbon alloys, boron-silicon alloys, tantalum carbide, titanium carbide, zirconium di-boride, beryllium, hafnium, cobalt, tungsten, vanadium, and molybdenum. Mechanical properties, microstructures, and transition studies were carried out. Complete chemical analyses are also given for the interstitial elements in the metals and compounds. (auth)

22673 (WADD-TR-60-418) DEVELOPMENT OF OPTIMUM METHODS FOR THE PRIMARY WORKING OF REFRACTORY METALS. R. B. Simonson, J. R. Long, R. W. Tombaugh, and R. C. Green (Harvey Aluminum Torrance, Calif.). Apr. 1960. Contract AF33(616)-6377. 172p.

The Metal Working Facility is described; the development of extrusion techniques, extrusion effort, and the metallurgical evaluation resulting therefrom are discussed. (auth)

22674 (WADD-TR-60-646(Pt.I)) CARBONIZATION OF PLASTICS AND REFRACTORY MATERIALS RESEARCH. PART I. J. A. Coffman, G. M. Kibler, T. R. Riethof, and A. A. Watts (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Oct. 15, 1960. Contract AF33(616)-684. 89p.

Experimental investigations concerned with the rate and mechanism of the carbonization of plastics, the measurement of the vapor pressure of refractory materials, and the determination of the spectral emissivities of refractory materials are described. Experimental techniques being used to study the carbonization of plastics include thermogravimetric analysis, fluid-bed carbonization of powdered resin, and arc image furnace experiments in which the plastics are exposed to temperatures approaching those of actual ablation applications. Vapor pressure studies are being conducted using the Langmuir evaporation technique. In addition matrix-isolation techniques and resonance-line absorption spectroscopy are being applied to the study of vapor species. Materials studied are tantalum carbide, zirconium carbide, and thoria. Normal spectral emissivities of tungsten, tantalum carbide, and zirconium carbide were measured between 1800 and 3000°K using an emissometer designed and built for this purpose. (auth)

22675 (WADD-TR-60-718) ELECTROPLATED CERMET COATINGS FOR OXIDATION PROTECTION OF SUBSTRATES IN EXCESS OF 2000°F. James C. Withers (American Machine and Foundry Co., Alexandria, Va.). Oct. 1960. Contract AF33(616)-6807. 83p.

A method was developed for electrodepositing cermet deposits of nickel, chromium, platinum, rhodium, and cobalt-tungsten and Al_2O_3 , ZrO_2 , SiO_2 , and MoSi_2 . Deposits of these cermets were oxidation tested at 2000°F (1093°C) and 2500°F (1371°C). Those cermets showing less weight change than the pure electroplated metal were plated on molybdenum and tested at the test temperature. A nickel- ZrO_2 cermet coating 5 mils thick protected molybdenum for 468 hours at 2000°F. A chromium- ZrO_2 cermet protected molybdenum for 2 hours and 20 minutes at 2500°F, while a nickel- SiO_2 cermet protected molybdenum for greater than 5 hours at 2500°F. (auth)

22676 (WAPD-238) CHEMICAL REPLACEMENT PLATING OF ZIRCALOY. C. R. Woods and T. R. Padden (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 1961. Contract AT-(11-1)-GEN-14. 37p.

One of the methods investigated for the bonding of PWR Core 2 fuel plates was eutectic-diffusion-bonding. As part of this investigation, a study of chemical replacement plating of suitable bonding agents onto Zircaloy was initiated to obtain detailed information of process variables, including the effects of bath composition, preplating surface treatments, and bath agitation on the quality of deposits. The replacement plating of multiple bonding agents such as Cu-Fe and Cu-Sn on Zircaloy is described, as are several procedures for measuring the thickness of plated deposits. (auth)

22677 (JP RS-8260) ELECTROSLAG REMELTING OF STEEL. A. F. Tregubenko, V. G. Speranskii (Speranskiy), and S. A. Leybenzon. Translated from *Stal'*, 21: 233-8 (Mar. 1961). 15p.

The furnace is described as consisting of two units, operating alternately, each with three crystallizers. The furnace is powered by a 2250-kva transformer at a current strength of 6 to 7 ka and 50 v. The process is outlined for which about 3 hours are required to produce a 700-kg ingot. The method is considered to sharply improve the properties of a metal. Irrespective of the quality of the initial electrode, the electroslag metal has a dense macrostructure, is almost free of porosity, and is considerably less contaminated with nonmetallic inclusions, any linear distribution or accumulation of which is completely eliminated. (B.O.G.)

22678 (NP-tr-608) FLAME SPRAYING OF ALUMINA. H. Meyer. Translated by R. Todd (U.K.A.E.A., Atomic Energy Research Establishment) from *Werkstoffe u Korrosion*, 11: 601-16(1960). 63p.

An examination was made of the processes occurring during the flame spraying of aluminum oxide. To determine the residence time of the particle in the flame, the temperature distribution in the flame and the velocity of the corundum particles in the gas jet were measured. The temperature of the flame was measured using a thermocouple, and found to be about 2,000°C. It was determined that the particles had a velocity of 100 m/sec. The quality of the sprayed layer was dependent on the particle size of the powder used. The hardness of the layers was determined by the Vickers method using a Leitz hardness tester. The maximum bending angle increased with increasing porosity. The porosity of a sprayed layer was due basically to its structure as an assembly of individual particles which have more or less retained their individual boundaries and spherical form. The permeability of the layers was found to approach zero as the layer thickness increased. Experiments showed that the adhesion is not due solely to a mechanical clamping but depends to some extent on a chemical interaction between the ceramic material and the metal oxide. The measured value of the adhesive strength was dependent on temperature. It was found that the cubic modification of the aluminum oxide is stabilized by the addition of lithium oxide. Values were obtained for the thermal conductivity and coefficient of expansion of the layer. The protective effects of the coatings were shown in oxidation experiments. The suitability of other ceramic oxides in flame spraying is discussed. (M.C.G.)

22679 (NP-tr-609) FORGING AND PRESSING OF HEAT-RESISTANT ALLOYS. D. I. Berezhkovskii (Berezhkovskiy). Translated from *Metalloved. i Obrabotka Metal.*, No. 8, 51-61(1957). 29p.

Problems related to fabrication of large forgings from heat-resistant alloys and those related to metallurgical preparation of these alloys are similar. A survey is presented on problems related to metallurgy which effect the behavior of ingots during forging and pressing. (J.R.D.)

22680 (NP-tr-612(p.68-82)) ARC FUSING OF MOLYBDENUM IN A VACUUM. A. S. Stroyev, E. (Ye.) S. Ovsepyan, and A. M. Ivanov. Translated from p.470-7 of "*Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovaniy*, 1956," Moscow, 1959.

The production of molybdenum by electric arc fusing with an expendable electrode is discussed. Moldings 16 × 16 mm in cross section and 400 to 500 mm in length and with an oxygen content of 0.006 to 0.01% were used as electrodes. The joining of the moldings was accomplished

by butt welding. High vacuum was a necessary condition for smelting molybdenum in view of the easy oxidation of the metal on heating above 700°C. The layout of the arc furnace is described. Tests on the selection of deoxidizers and methods of introducing them showed that the best deoxidizers of molybdenum are carbon, zirconium, and titanium. The content of oxygen and other gases in the smelted metal under various fusing conditions is given. (M.C.G.)

22681 (NP-tr-614) THE PROBLEM OF THE NATURE OF CRYSTALLINE CRACKS DURING THE WELDING OF AUSTENITIC STEELS AND ALLOYS. B. I. Medovar. Translated from *Avtomat. Svarka*, 12: No. 8, 57-66(1959). 22p.

The present state of knowledge regarding crystalline cracks in welded seams of austenitic steel is reviewed, and the polygonization hypothesis of B. A. Movchan is criticized. Experiments in which the welding speed was increased failed to improve the welded seams, and a survey of other experimental results indicates that Movchan's hypothesis requires further proof. (D.L.C.)

22682 FORGING UNCLAD BERYLLIUM. J. P. Denny (Beryllium Corp., Reading, Penna.) and J. D. McKeogh. *J. Metals*, 13: 432-3(June 1961).

A forging development program has demonstrated that hot-pressed beryllium metal may be bare forged successfully into certain configurations. Technical details of the required procedures are presented, and the results are evaluated. (auth)

22683 STUDY OF THE EXPANSION OF ZIRCALOY 2 TUBES ON STEEL. J. Jay, J. Dreuilhe, and P. Thomé. *Rev. mét.*, 58: 351-62(Apr. 1961). (In French)

The tubes of force in a nuclear reactor must form a tight joint with the tank and the system leading to the heat exchangers. They must also be replaceable while the reactor is working. The characteristics of assembly by mandrel expansion of the zircaloy tubes on steel sheaths are studied and the problems of achieving this assembly by remote manipulation while the reactor is working are examined. (auth)

22684 PROCESSING OF SPECIAL MATERIALS FOR NUCLEAR REACTORS. *Riv. ing.*, 10: 361-71(Apr. 1961). (In Italian)

The working on fabricating techniques for the various special reactor materials are summarized. The materials considered are Zircaloy-2, graphite, concretes, W alloys, U, and aluminum X8001. A section on protection against radiation and poisoning is included. (T.R.H.)

22685 [UPGRADING TRACER LATHE MACHINE OPERATIONS. J. Bryan, J. Bowerbank, E. Holland, and O. Mohl. Paper No. 362. Presented at a Meeting of the American Society of Tool and Manufacturing Engineers, New York, May 22-26.] 46p. (UCRL-6275)

A tracer lathe check was developed to locate and determine quantitatively the errors of tracer lathe machining. The lathe check provides data of first order errors. The first order errors data analysis provides a means of correlating lathe errors with the error of a finished part. The correlation of error data shows what non-lathe errors are present and what part of the lathe needs reworking. With the information provided by the lathe check, the machining tolerance limitation of a lathe can be determined. The lathe check is divided into six parts. The first check provides data of the composite non-lathe machining error. The other five checks provide data of lathe operation error. Each check is explained and a means of reducing the machining

errors found to be a tolerable level is suggested. The equipment needed and a step-by-step procedure for each check is also given. (auth)

22686 POWDER METALLURGY IN NUCLEAR REACTOR CONSTRUCTION. Henry H. Hausner (International Atomic Energy Agency, Vienna). 1961. 72p. (STI/Pub/15/11)

A review is presented on the general principles and techniques of powder metallurgy and methods for fabrication of powder particles, together with methods for powder fabrication for nuclear engineering processes and principles for safe handling of these materials. Special emphasis is given to the powder metallurgy fabrication of materials such as U, U alloys and compounds, Th, and dispersion-type materials. Dispersion hardening is considered. Preparation of control materials, moderators, and construction materials is discussed. Other items discussed include fiber powder combinations, sinterwelding, and sintering under irradiation. (D.L.C.)

22687 PROCESS OF FORMING POWDERED MATERIAL. J. Glatter and B. E. Schaner (to U. S. Atomic Energy Commission). U. S. Patent 2,991,601. July 14, 1961.

A process of forming high-density compacts of a powdered ceramic material is described by agglomerating the powdered ceramic material with a heat-decomposable binder, adding a heat-decomposable lubricant to the agglomerated material, placing a quantity of the material into a die cavity, pressing the material to form a compact, pretreating the compacts in a nonoxidizing atmosphere to remove the binder and lubricant, and sintering the compacts. When this process is used for making nuclear reactor fuel elements, the ceramic material is an oxide powder of a fissionable material and after forming, the compacts are placed in a cladding tube which is closed at its ends by vapor tight end caps, so that the sintered compacts are held in close contact with each other and with the interior wall of the cladding tube.

22688 HOT PRESSING TO FORM CANNED URANIUM SLUGS. S. B. Roboff and W. E. Kingston (to U. S. Atomic Energy Commission). U. S. Patent 2,993,786. July 25, 1961.

A method of making compacts and clad slugs from powdered uranium is described. The powdered uranium is introduced into a die and subjected to pressures of 30 to 100 tsi while maintaining a temperature within the range of 450 to 660°C.

Properties and Structure

22689 (60-RL-2375M) THE TECHNOLOGY OF HIGH-TEMPERATURE CERAMICS. Louis Navias (General Electric Co. Research Lab., Schenectady, N. Y.). Mar. 1960. 59p.

As background for studies of refractory materials the melting point and electric conductivity of metals, oxides, borides, carbon and graphite products, carbides, nitrides, and silicides with melting points above 1500°C are dealt with. The data are given in graphical form for easy comparison. Short descriptions of preparation and other properties are given in some cases. A brief summary of the known methods of obtaining high temperatures is also given in graphical form with a note on measuring these temperatures. (auth)

22690 (AE-50) PHASE TRANSFORMATIONS IN A URANIUM-ZIRCONIUM ALLOY CONTAINING 2 WEIGHT PER CENT ZIRCONIUM. G. Lagerberg (Aktiebolaget Atomenergi Stockholm). Apr. 1961. 39p.

The phase transformations in U-Zr alloys containing 2 wt% Zr were examined metallographically after heat treatments involving isothermal transformation of γ and cooling from the γ -range at different rates. Transformations on heating and cooling were also studied in U-Zr alloys with 0.5, 2 and 5 wt% Zr by means of differential thermal analysis. The results are compatible with the phase data obtained by other workers. (auth)

22691 (AFOSR-730) OBSERVATIONS ON THE GROWTH OF α -IRON SINGLE CRYSTALS BY HALOGEN REDUCTION. C. M. Wayman (Illinois Univ., Urbana). [1959]. 15p.

By increasing the scale of conventional techniques, it was possible to grow single crystals of α -iron one to two mm in diameter and 80 mm long. It was felt that the final size of the crystals, for given reducing conditions, depends on the amount of salt available for reduction. A typical boat of crystals grown under the conditions described is shown. The crystals are seen to have a tendency to grow in clumps, with many crystals appearing to radiate from a common nucleus. Crystals having a dendritic appearance were observed following a process when the system was accidentally opened to the atmosphere. The results of turning off the furnace and permitting it to cool before all the chloride had reacted was the formation of FeCl₂ crystals at various places when the temperature reached the vicinity of the melting point of the salt. (B.O.G.)

22692 (ANL-6330) ANNUAL REPORT FOR 1960, METALLURGY DIVISION. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 273p.

Development and Fabrication Programs for EBR-II. The thermal conductivity of U-5 wt % Fs (fissium)-2.25 wt % Zr alloy was measured at 0 to 800°C. The heat enthalpy of U-5 wt % Fs is greater than that for U at temperatures up to 350°C; above 350°C, the enthalpy of U is higher. Phase studies of U-Pu-Fs alloys with and without Zr additions are reported. Metallographic examinations were made on specimens taken from the top, center, and bottom of injection-cast U-20 wt % Pu-10 wt % Fs fuel pins. Diffusion penetration by U-20 wt % Pu-10 wt % Fs was measured for the following potential canning materials: Ti, Mo, V, Ta, Y, Nb, Nb-5.3 wt % V, Zr, Zircaloy-2, and 347 and 430 stainless steel. Irradiation behavior of U-Fs and U-Pu-Fs alloys is discussed. Thermal cycling tests of EBR-II blanket slugs indicate the cycling behavior to be unaffected by differing cooling rates from the beta phase. Methods and equipment used in refabricating irradiated fuel into elements suitable for return to EBR-II are described in detail, and production results for both fuel pins and blanket rods are given. EBR-II steam generator fabrication is discussed. EBR-I Core IV Fuel Elements. Casting methods were evaluated for fabrication of Pu-1 wt % Al alloys. The following properties were measured for Pu-1 wt % Al: (1) thermal conductivity at 100 to 600°C, (2) hot deformation or slumping tendency at 7 to 60 psi load, and (3) hardness. Densities of five Pu-Al alloys of composition ranging from 0.26 to 3.06 wt % Al were determined. Fabrication of Zircaloy jacket components, uranium blanket slugs, and stainless steel hardware for EBR-I Core IV is described. EBWR Core 1-A Spike Fuel Elements. A ZrO₂-CaO- UO_2 solid solution ceramic was fabricated in the form of pellets to permit EBWR operation at 100 Mw(t). Fabrication of Zircaloy-2 hardware and fuel element assemblies for the spike elements is described. Thermal cycling test results are presented for Al-U₃O₈ fuel rods. Borax V Boiling and Superheater Fuel Elements. Fabrication of Borax V boiling and superheater fuel elements is discussed in some detail. Ceramic Fuel Materials. Direct reaction of UO_2 and C as a

means of producing UC was investigated in argon atmosphere. Reactions of UO_2 and C powders yielded a heterogeneous mixture with UO_2 predominating, while UO_2 reacts with petroleum pitch in alcohol to give UC with not more than 10% UO_2 . Metallographic results of UC are reported; a U_2C_3 surface layer was observed. PuC pellets were arc melted, and the following properties were studied for the compositions of 42.1 to 59.6 at.% C: density, microhardness, heat treatment behavior, and thermal expansion. The densification of uranium-thoria solid solutions during both air and H_2 sintering was studied, and the density changes of air-sintered U_3O_8 - ThO_2 were found to be influenced greatly by the composition, while H_2 sintering yielded the highest sintered densities. Weight losses and stoichiometry of air-sintered U_3O_8 - ThO_2 compositions were also measured. La_2O_3 - U_3O_8 mixtures were calcined and milled to give solid solutions which were quite stable in air. However, solubility limits and lattice parameters measured under three different heat treatments indicate stoichiometry differences. Deviations from stoichiometric $\text{MO}_{2.00}$ were measured for H_2 - and air-sintered La_2O_3 - U_3O_8 compositions. Three types of glasses were tested for possible use as a single-phase fuel material with U_3O_8 ; one type, Na_2O - K_2O - SiO_2 , did not devitrify when mixed with various amounts of U_3O_8 . The sintered densities of various MgO-fueled glass mixtures were determined. Isothermal heat treatment of a 30% UO_2 - Na_2O - CaO - SiO_2 glass in a 304-L stainless steel capsule at 800°C for 650 hr gave evidence of a slight reaction approaching a bond. Sintered 85 wt % boron carbide-glass mixtures fabricated in the shape of pellets and rods were found to have good mechanical strength. Sintering studies of US and ThS were carried out and their electrical resistivities measured. Irradiation Evaluation of Fuel, Control, and Structural Materials. The effects of cladding and internal venting on the swelling characteristics of clad U-2 wt % Zr specimens were studied at burnups of 1.4 to 2.1 at.% and temperatures of 620 to 1260°C. The results indicate that vent holes combined with cladding restraint can extend the application of metallic fuels to higher temperatures. Dimensional stability of Th-5 wt % Pu and Th-10 wt % Pu after 1.4 and 2.3 at.% burnups was found to be excellent. Metallographic examinations of irradiated Al alloy-clad, Pb-bonded ThO_2 - UO_2 pellets after cladding failures are reported. Irradiation testing of Th-U alloys containing 10 to 28 wt % U showed good irradiation stability up to 20 wt % U; higher U contents were less stable. The program for development of control materials containing lanthanides is briefly described. A scheme is outlined for monitoring the irradiation effects in the Borax V pressure vessels with specimens of the same material as the vessel. Development of instrumented high-temperature irradiation capsules for use in the CP-5 reactor is described. Examination of Full-Scale Fuel Elements. The results and conclusions of a metallurgical evaluation of failed Borax IV fuel elements are discussed. Since testing of EBWR Core IA fuel elements indicated possible water channel blocking at 100 Mw, a device was developed for monitoring the water channel gaps. Corrosion-Resistant Fuel, Jacketing, and Structural Materials. Corrosion rates of U-3 wt % Ti with small amounts of Nb and Ru were measured up to 234 days in water. Corrosion results indicate that iodide thorium has better corrosion resistance than Ca-reduced thorium. Corrosion of Th-U alloys with U contents ranging from 5 to 40 wt % was studied in 150°C water, and Th-U-Zr alloys were also investigated. A large number of Th alloys were evaluated with respect to aqueous corrosion, and Al, Y, and Zr were found to be beneficial additives. Aqueous corrosion study results are presented for a low Si-Al alloy A28

which indicate the alloy to be an improved Al alloy. Corrosion of a number of binary Al alloys was studied, and Co and Rh were found to be beneficial additives. Strengthening of Al alloys was studied. Corrosion of X8001 Al by H_3PO_4 and of Al-Ni-Fe by superheated steam was investigated. Studies of Zr alloy corrosion by superheated steam and absorption of H_2 are reported. Corrosion results of Fe containing various O_2 contents in water are summarized; higher O_2 contents appear to be beneficial. Corrosion by superheated steam was studied for the following Fe alloys: 304 and 347 stainless steels; Martin alloys 258, 259, and 261; and Croloy 2 $\frac{1}{4}$ and 5. 18-8 stainless steel and X8001-coated low-C steel were tested in dilute H_3PO_4 solutions. Mercury corrosion tests at 370°C and 100 psia were made on Ti, Ti alloy A110-T, and 304 stainless steel. Non-destructive Testing Developments. Various nondestructive techniques developed or being evaluated for use with reactor and nuclear materials are described: ultrasonics, eddy currents, neutron radiography, and gamma radiography. Fast Reactor Safety Program. Various joining problems encountered in thermocouple fuel element fabrication for TREAT are described. Dummy fuel rods and slot liner-capsule assembly for TREAT are described. Fabrication of ZrO_2 - CaO - UO_2 and UO_2 -304 ELC stainless steel fuel samples is discussed. Preparation of High-Purity Materials. High-purity Pu buttons produced by electrowinning with PuF_4 dissolved in KCl - LiCl were analyzed for their impurities and the results given. Densities of cast Pu of varying impurity content were determined. Cs_2UCl_6 was used in electrowinning U and U yields up to 73% were obtained; however, Cs_2PuCl_6 was found to be poor for either electrowinning or electrowinning of Pu. Texture Studies. High-purity rolled U sheet prepared in such a way that the starting grains are uniform and small was studied; recrystallization at low and moderate temperatures was found to result in formation of very fine grains and then discontinuous growth of larger grains. X-ray pole figures are presented for as-rolled U and for annealed-rolled U. Recrystallization at low temperatures was found to result in a preferred orientation different from that of as-rolled material. Recrystallization textures in single α zirconium crystals was studied under compressive deformation, and deformation mechanisms are derived for different crystals. Uranium and Plutonium Alloys. The temperature of formation of U_2Ru_3 is estimated to be near 1000°C. The structure of U_2Ru was derived from x-ray work. A thermal conductivity vs temperature plot is presented for various U-Fs alloys. Some results of a phase study of U-Pu-C are reported. A technique was developed for obtaining the lattice parameters of α uranium phases by the Debye-Scherrer method, and results are presented for pure α uranium. Alloying properties. The saturation magnetization of Fe-V alloys was measured with the alloys in the form of the metastable bcc α phase and after a series of anneals at 625°C which gave a σ phase. The results indicate CsCl-type ordering. Lattice contractions are plotted against radii ratios for CsCl-type compounds between Cu, Ag, Au and the lanthanides. Crystal structures were determined for Laves phases and for binary AB_3 compounds. The c/a ratios of hexagonal TiNi_3 -type Apd_3 compounds were investigated as a function of the size factor. The occurrence of epsilon phases in various ternary systems is discussed. Intermetallic compounds which exist in binary systems of Nb with transition elements were investigated. A_2B phases are shown to exhibit either Ti_2Ni or Al_2Cu type phases, depending on the atomic size factor. Si_2Mo -type compounds were also studied. The miscibility of Laves-type phases in 51 ternary systems was determined; most were found to be

completely miscible. The dissolution rates of Ti, V, Cr, Fe, Co, and Ni in liquid Sn and Al were determined at 600 to 800°C. X-ray and Neutron Diffraction Studies. A stepping mechanism to be used with a horizontal neutron spectrometer is described. Available data on the structure of α uranium are compared; the variance of the parameter γ with temperature was measured. The crystal structures of CuTi_2 and Ti_2Ni were determined. Preliminary diffraction measurements on the structure of $\text{Na}_2[\text{Ru}(\text{NO}_2)_4(\text{NO})(\text{OH})] \cdot 2\text{H}_2\text{O}$ are reported. Magnetic structures of Mn-Co, Mn-Co-C, and Mn-Cu were derived from diffraction patterns made on null matrices. The results of an investigation of the neutron coherent scattering amplitudes of Ti isotopes are summarized. Neutron scattering amplitudes were determined for K^{39} and Rb^{85} in the form of chlorides. Ti washers, reacted with D_2 gas and then depleted to various degrees by an arc discharge, were examined to determine the state of D atoms in Ti. It was found that D reacts with Ti to form a metal deuteride with a structure different from that of the metal. Metal Physics. The temperature dependence of the elastic moduli of α uranium crystals was measured down to 1.1°K for C_{11} and to 35°K for C_{22} . Both sets of measurements indicate a sharp transition in the physical state at a temperature between 41 and 43°K. Revised calculations of the theoretical elastic moduli of α zirconium crystals were measured at 19.7°C and elastic parameters calculated therefrom. Work on diffusion in U is summarized. Diffusion of Cr in β uranium was found to behave differently from self-diffusion. A theoretical study of the mechanisms of twinning in Zr is presented, and ZrH habit planes in Zr were identified. Corrosion Research. The effect of applied current on the solution potential of Al and Co in boiling distilled water is illustrated by graphs. Corrosion of a large number of ternary Zr alloys was studied in dry O_2 and steam. Emf measurements of the growing ZrO_2 scale on various Zr alloys indicate that the alloys can be grouped into three classes according to their emf behavior. The implications of the corrosion studies of Zr are discussed. The Al content of the corrosion product lost from 1100 Al in 70°C water was determined as a function of time, and the reaction chemistry is discussed. The amount of Al corrosion in water was also followed over a one-year period. pH measurements at a point close to the Al surface in 50°C water are reported as a function of time. Relative corrosion pitting of four Al alloys in CuSO_4 solution at 50°C was studied. A mechanism is proposed for the corrosion of Al alloys by superheated steam. The results of an electron microscopic study of corrosion films formed on Al alloys and Fe by high-temperature water are presented. Irradiation Effects. A detailed investigation was made on the swelling behavior of U and U alloys after postirradiation annealing; some of the variables studied were annealing temperature, annealing time, and burnup. Evaporated Au films irradiated with fission fragments from natural U were studied by electron microscopy; results indicate that one fission fragment produces ~10 damage spots along its path in Au. The anisotropy of fission fragments escaping from U crystals into Ilford K-2 emulsions was determined to be less than 15%. Ceramic Materials Research. The sintering rates of single Al_2O_3 crystals were studied and a diffusion coefficient derived: $D = 5 \times 10^8 \sqrt{P_{\text{O}_2}} \exp(-150,000/\text{RT})$. Since the activation energy agrees well with that measured for O_2 diffusion, the rate-controlling mechanism in Al_2O_3 sintering appears to be O_2 diffusion. A sphere grinder and furnace for sintering studies are described. A detailed study of reduction of uranium oxides of compositions between U_3O_8 and UO_2 by CO and H_2 was made. The reaction

rates were found to obey the following equations: for H_2 , $dP/dt \propto g^{1/2} P \exp(-33,000/\text{RT})$, and for CO, $dP/dt \propto g^{1/2} P^{1/2} \exp(-4,000/\text{RT})$, where P = pressure and g = sample weight. The rates are relatively independent of the over-all oxide composition. (D.L.C.)

22693 (ANL-6359) PAPERS AND DISCUSSION FROM THE X-RAY PREFERRED ORIENTATION MEETING HELD AT ARGONNE NATIONAL LABORATORY, DECEMBER 15 AND 16, 1960. Melvin H. Mueller, ed. (Argonne National Lab., Ill.). May 1961. Contract W-31-109-eng-38. 88p.

Eleven papers are included of which nine were separately abstracted. The remaining two papers appear in NSA; one, on dimensional changes in U during irradiation, appears in Vol. 15, abstract no. 4341, and the other, on x ray preferred orientation, appears in Vol. 14, abstract no. 19415. (J.R.D.)

22694 (ANL-6359(p.20-34)) STATUS OF THE GROWTH INDEX FORMALISM. Edward F. Sturcken (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

Work on various aspects of the irradiation growth parameter G_2 and the quantitative preferred orientation parameter J is described. The $P(u, \phi)$ matrix for G_2 is now correct by independent verification for the 20-plane case and for the 18-plane case. The ability of J to describe the same shape at different orientations in space was tested. J was found to be invariant for six spatial orientations of the same ellipsoid, as shown to be related through a simple constant to statistical variance, σ^2 . A set of two-dimensional Fourier expansion functions, $P(\gamma, \phi)$, were tried in place of $P(u, \phi)$ to see if they were superior. It was found that the Fourier functions required more complex calculations for G_2 and J and, hence, were undesirable. An irradiation experiment was prepared, in which PO is the only variable, to study PO as expressed by the strain tensor concept, i.e., G_2 or G_3 , versus irradiation growth. The encapsulation technique and the PO x ray measurements for the irradiation test specimens are described. (auth)

22695 (ANL-6359(p.35-40)) CORRELATING FABRICATION CONDITIONS AND GROWTH INDEX DATA. Leonard Robins (Bridgeport Brass Co., Conn.).

The problems associated with production of dimensionally stable fuel elements are complicated by the presence of the many variables introduced by the thermal and mechanical treatments usually employed in shaping uranium. The list of possible variables might include the impurity content, preliminary working and heat-treating operations, heating or cooling rates, temperatures, time at temperature, type and amount of plastic deformation, secondary working operations, etc. A logical approach for investigations of growth index is to narrow the long list of possible factors affecting the preferred orientation to the few most influential ones that can be easily handled in commercial fabrication practice. The screening of a large number of possible variables to identify the most important ones is a type of problem that arises in many investigations in one form or another. When the problem is one of optimizing fabrication conditions, precise experimental designs, containing the few critical variables previously identified, can be made. The optimum operating conditions may be determined in a limited number of tests by a conventional study of the most significant variables, while the other variables are held constant. (auth)

22696 (ANL-6359(p.41-2)) EMPIRICAL APPROACH TO FUEL ELEMENT IRRADIATION GROWTH PREDICTION. J. P. LeGeros (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.).

Since a theoretical mechanism to explain the change in dimensions of fuel elements during irradiation has not been proven to date, an empirical approach to the problem of

ertifying test fuel elements to be irradiated in production reactors was evaluated. Texture-limit standards are being established, on a preliminary basis, by measuring the textures of standard production fuel elements taken daily from the production cladding-fabrication process. This work is being done in two phases. In the first phase, the maximum and minimum axial textures (measured on one diffraction sample from a slug out of the production line each day for eight months) were set as upper and lower limits between which experimental slugs were certified as probably safe for production reactor irradiation. In the second phase, texture standard limits are being based upon a larger sampling of twenty samples (ten axial and ten in the direction of the circumference) taken from a production slug each day. A significant correlation was found between growth and the temperature of the coolant surrounding the fuel element. (J.R.D.)

22697 (ANL-6359(p.43-50)) COMPARISON OF METHODS OF CALCULATING THE GROWTH POTENTIAL OF URANIUM. J. W. Starbuck and H. C. Kloepper, Jr. (Mallinckrodt Chemical Works, [St. Louis]).

Three methods of calculating the growth potential of uranium were applied from a Jominy-type end-quenched uranium specimen. Scaled growth index (G.I.) yields a somewhat more negative value than does G_2 or G_3 , especially for sections having high C-axis texture. The effects of changes in certain constants employed in the calculations were evaluated. Reduction of the cosine-squared functions from five decimal places to two decimal places resulted in insignificant changes in scaled G.I. and G_3 . A test of the significance of differences in inverse matrices of the G_2 formalism also indicated inconsequential effects upon the calculated G_2 value. (auth)

22698 (ANL-6359(p.51-4)) INTERSITE EVALUATION OF PREFERRED ORIENTATION DATA. J. W. Starbuck and H. C. Kloepper, Jr. (Mallinckrodt Chemical Works, [St. Louis]).

X-ray-determined preferred orientation data observed at MCW and HAPO laboratories were in excellent agreement with respect to texture coefficients and G_3 observations. It appears that the procedures have been sufficiently standardized for exchange and comparison of data between the two sites. (auth)

22699 (ANL-6359(p.55-7)) BRIEF DESCRIPTION OF THE "AREA-WEIGHT" TREATMENT FOR THE 18-PLANE SET. R. N. Thudium and P. R. Morris (National Lead Co. of Ohio, [Cincinnati]).

The poles of 18 crystallographic planes of uranium were projected on the surface of a sphere. Arcs of great circles were drawn equidistant between a pole and each of its nearest neighbors. Thus, a spherical polygon was formed about each pole. The polygon was divided into spherical triangles and the chords of each triangle were measured with dividers. The surface area of each triangle was determined from the chord lengths. The areas of individual triangles were summed to give the area of each polygon. Data are tabulated on the diffraction planes, calculated random intensities, area weight factors, squares of direction cosines, and products of area weight factors and squares of direction cosines. (auth)

22700 (ANL-6359(p.58-66)) SOME PROBLEMS AND FACTS IN THE DETERMINATION OF GROWTH INDEX IN BETA-TREATED URANIUM. R. B. Russell (Nuclear Metals, Inc., [Concord, Mass.]).

The determination of texture in beta-treated uranium is somewhat different from the determination of that of alpha-

fabricated metal. In the latter case, the grain size is usually much smaller, so that a texture determination is more reliable, but the difference which gives rise to more problems is that the texture of beta-treated metal is practically random, with the result that the greater number of diffracting peaks tend to interfere with each other, making their quantitative intensity measurements more difficult. It seems clear that there are only two weighting possibilities: quantized or continuous. The quantized method is exemplified by point weighting (such as K_2 , which has not been pile tested, and G.I. which has) or area weighting (such as G_3). Discussions of diffraction peaks and their resolution, separation by differential thermal expansion, use of crystal monochromometer, aspects of pole densities and growth index in beta-treated U rods and tubes are included. (J.R.D.)

22701 (ANL-6359(p.67-78)) RECRYSTALLIZATION IN ROLLED URANIUM SHEET. Lowell T. Lloyd and Melvin H. Mueller (Argonne National Lab., Ill.).

An investigation of the occurrence of recrystallization without an apparent preferred orientation change was undertaken. The work was conducted with high-purity uranium. The individual results are not much different from those of the earlier work. A plot for the change in mean coefficient of expansion of transverse samples as a function of volume per cent of recrystallization is included. The samples annealed at lower temperatures did not show significant changes in expansion coefficient, whereas those annealed at higher temperatures did. The material from the first work seemed to recrystallize at a lower temperature than that used currently. This is probably associated with the greater heterogeneity of deformation in the former. Studies show that recrystallization, at low and moderate temperatures, of high-purity uranium sheet reduced approximately 80% in thickness at room temperature is characterized by the formation of extremely fine recrystallized grains which are later absorbed by growth of larger grains. (auth)

22702 (ANL-6359(p.86-8)) THE DETERMINATION OF THE γ POSITIONAL PARAMETER IN ALPHA URANIUM AS A FUNCTION OF TEMPERATURE. Melvin H. Mueller, Harold W. Knott, and Richard L. Hitterman (Argonne National Lab., Ill.).

Preliminary results of alpha uranium structural investigations are discussed. Low- and high-temperature data for the γ positional parameter were obtained on a uranium single crystal, which is approximately $3/16$ -inch square with the major crystal faces corresponding to the cube faces within approximately one degree. A least-squares calculation program on the IBM-704 was used. In order to compare the results obtained by a minimization technique with the least-squares technique original data was used. A summary of results obtained by various investigations together with those from the presently investigated crystal are shown. (auth)

22703 (ARF-2194-3) A STUDY OF THE Ti-ZrO₂ SYSTEM. Progress Report No. 3, September 15 to December 15, 1960. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 15, 1960. Contract AF33(616)-7074. 13p. (AD-249532)

Phase relationships along the vertical section from Ti to ZrO₂ were being investigated in the Ti-Zr-O system. Alloys were prepared by arc-melting calculated amounts of high-purity titanium and zirconium dioxide. Where alloy compositions are not on the Ti-ZrO₂ line, high-purity zirconium and titanium oxide were utilized as well. A total of forty-five compositions were melted. Selected samples were annealed and quenched from temperatures between

600° and 1600°C. These samples were submitted for metallographic preparation and study. A cursory melting point-composition study was conducted. Some x-ray work was done. A preliminary Ti-ZrO₂ vertical section is presented. (auth)

22704 (ARF-2196-9) HARDENING OF COLUMBIUM BY INTERSTITIALS. Final Report, March 4-December 3, 1960. J. B. McAndrew and C. R. Simcoe (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Dec. 23, 1960. Contract DA-11-022-504-ORD-3354. 28p. (AD-248580)

Studies of Nb with combined additions of interstitial and substitutional solutes show that the addition of O₂ together with Ti or Zr is an excellent method of preparing forgeable Nb alloys with good high-temperature strength and adequate low-temperature ductility. Nb-1.5% Ti-0.50% O had triple the strength of pure Nb up to 2200°F and was ductile at temperatures from -76 to +2200°F. (D.L.C.)

22705 (ARF-2210-3) IMPROVED VANADIUM-BASE ALLOYS. Bimonthly Report No. 3 [for] April 1, 1961-May 31, 1961. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 23, 1961. Contract NOW 61-0417-c. 13p.

Promising V-Nb alloys were produced and fabricated to sheet by hot or cold working techniques. Excellent workability was evidenced by the fact that most of the compositions could be rolled to 0.050-inch sheet. Metallographic and hardness studies on the sheet materials indicated that boron and carbon added to V-1Ti-60Nb raises the recrystallization temperature 200° to 400°F. Short-time stress-rupture properties were determined for several alloys at 2000°F; the alloy V-5Ti-20Nb-0.05C failed after 22 hours at a stress of 10,000 psi. A 50-pound ingot of V-5Ti-20Nb was double arc-melted and extruded to 3-inch diameter bar by a commercial vendor. Externally the bar appeared to be sound. (auth)

22706 (ARL-5) GRAIN SIZE EFFECTS ON THE THERMAL CONDUCTIVITY OF CERAMIC OXIDES. J. R. Tinklepaugh, R. S. Truesdale, J. J. Swica, and W. R. Hoskyns (New York. State Univ. Coll. of Ceramics, Alfred). Feb. 1961. 77p. Contract AF33(616)-3798.

Dense, fine-grained alumina samples were employed in a study of the effect of grain size on thermal conductivity in polycrystalline alumina. The thermal conductivity in the temperature range from 100 to 1000°C decreased slightly but significantly as the average grain size was varied from 10 to 4 to 2. The decrease in thermal conductivity with decreasing grain size was found to follow closely an additive reciprocal volume relationship, which was previously discussed by several investigators. The role of impurities in masking this effect in dense alumina samples of purity exceeding 99% was shown by measuring the thermal conductivity of specimens with small variations in impurity content. The strength and modulus of elasticity of these fine grained aluminas were also measured. Several questions were raised concerning the data obtained which were not resolved. Dense samples of MgO were also produced using hot pressing techniques and strength and elasticity properties measured. These results are incomplete and not well understood. (auth)

22707 (CF-60-1-54) Ni-o-nel VERSUS HASTELLOY F AS A MATERIAL OF CONSTRUCTION FOR SULFEX PROCESS EQUIPMENT. W. E. Clark (Oak Ridge National Lab., Tenn.). Jan. 25, 1960. 7p.

On the basis of published results Ni-o-nel is definitely superior to Hastelloy F in Sulfex systems. In Zirflex systems they appear to be closely competitive. Expected maxi-

mum rates for Ni-o-nel in the Sulfex-Thorex cycle are 1.5-2.5 mils/mo over all and ≤ 8.5 mils/mo locally. Scouting, single-solution tests indicated rates 2 to 10 times these over-all rates for Hastelloy F. Single solution tests in Zirflex systems gave rates as high as 12 mils/mo for Ni-onel and 15 mils/mo for Hastelloy F. Over 7 to 11 cyclic Zirflex dissolutions maximum Ni-o-nel rates were about 5 mils/mo. Weld-corrosion problems may necessitate special heat-treatments of both alloys. It appears likely that Hastelloy F is not truly competitive with Ni-o-nel for construction of ORNL processing facilities unless HNO₃-H₂ systems are to be considered. (auth)

22708 (CRCE-991) MELTING POINTS AND OTHER PHYSICAL PROPERTIES OF SOME TERPHENYL-BASED REACTOR COOLANT MIXTURES. S. R. Hatcher (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1961. 36p. (AECL-1223).

Liquidus points were determined on synthetic mixtures of biphenyl, terphenyls, and radiolytic high boilers. In the composition ranges of interest to OCDRE the component having the largest effect on the melting points was p-terphenyl. None of the mixtures had liquidus points below room temperature. The compositions giving the lowest liquidus points can only be recommended for use in OCDRE provided that all parts of the cooling system can be maintained at a temperature of at least 70°C. The effect of biphenyl content on high-temperature vapor pressures of terphenyl-based coolants was calculated, and some measurements of low-temperature viscosities are reported. (auth)

22709 (CRGM-995) THE PERMEABILITY AND DIFFUSION OF HYDROGEN IN M-257 ALUMINUM-ALUMINUM OXIDE ALLOY. A. Sawatzky and M. J. Rees (Atomic Energy of Canada Ltd., Chalk River, Ont.). Apr. 1960. 27p. (AECL-1252)

The permeability of hydrogen in M-257 Al-Al₂O₃ alloy was investigated at room temperature to 600°C for various surface conditions. Diffusion through the surface oxide was found to be the rate-determining mechanism. The diffusivity of hydrogen in M-257 alloy was also determined at 400 to 600°C. The results were found to be lower than those for pure Al. (auth)

22710 (DASA-1187) A METHOD TO DETERMINE THE THERMAL DIFFUSIVITY OF METALS AT HIGH TEMPERATURES. Lab. Project 5046-3, Part 123, Final Report. J. E. Dennis, A. Hirschman, W. L. Derksen, and T. I. Monahan (New York Naval Shipyard. Material Lab., Brooklyn). June 14, 1960. 33p.

An experimental method was devised for the determination of the thermal diffusivities of solid materials at 400°K to the melting point of the sample. Specimens are irradiated with a chopped beam in a carbon-arc image furnace. Phase lag between the square wave irradiance impinging on the front face of the specimen, measured by a photovoltaic cell, and the resultant sinusoidal temperature of the rear face, measured by a thermoelectric probe, provides a rapid determination of thermal diffusivity. Phase opposition of a square wave and a sine wave produces a null Lissajous figure on an oscilloscope. The diffusivity of iron was measured to range from 0.146 ± 0.012 cm²/sec at 400°K to 0.03 ± 0.01 cm²/sec at 1000°K; and of copper from 1.0 ± 0.2 cm²/sec at 500°K to 0.8 ± 0.1 cm²/sec at 900°K. The diffusivity of brass was 0.29 ± 0.04 cm²/sec throughout the range from 400 to 900°K. (auth)

22711 (DEG-Report-308) THE ABILITY OF VARIOUS MATERIALS TO ABSORB OR EMIT FISSION PRODUCTS: A METHOD OF ASSESSMENT. I. C. Hendry and J. Grif-

ths (United Kingdom Atomic Energy Authority. Development and Engineering Group, Dounreay, Caithness, Scotland). Jan. 25, 1961. 20p.

Data available on the absorption and transmission of fission products in different materials are reviewed. The available data were correlated to provide a method for estimating the range of fission products in any substance. The correlation is used as the basis of a method of assessing the fission-product production rate in the boundary layer of a fissile specimen, in a can surrounding a fissile specimen, and in a gas interspace between fissile material and canning material. (auth)

2712 (DMIC-152) BINARY AND TERNARY PHASE DIAGRAMS OF COLUMBIUM, MOLYBDENUM, TANTALUM, AND TUNGSTEN. J. J. English (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Apr. 28, 1961. Contract AF33(616)-7747. 224p. (PB-71421)

A compilation is presented of 93 binary and 68 ternary phase diagrams of the four refractory metals: niobium, molybdenum, tantalum, and tungsten. Included with each diagram is a discussion which lists information on the solubility and crystal structure of intermediate phases. When several investigations of a particular diagram are in disagreement, the discrepancies are discussed. Many of the diagrams are incomplete, and are subject to revision as more definitive data become available. However, they are included so that the readers may have as up-to-date information as possible on each of the systems. (auth)

2713 (DMIC-153) PHYSICAL METALLURGY OF NICKEL-BASE SUPER-ALLOYS. C. H. Lund (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 5, 1961. Contract AF33(616)-747. 39p. (PB-171422)

Nickel-base superalloys are discussed from the standpoint of strengthening mechanisms, heat treatment, and evolutionary history. Solid-solution hardening, precipitation hardening, strengthening by boron and zirconium additions, and failure are considered in general theoretical terms. Dislocation movement and coherency effects are discussed and related to elevated-temperature strength properties. The more prominent reactions taking place during the heat treatment of nickel-base superalloys are also described. The gamma prime and eta precipitates are discussed and observations are presented on the behavior of complex carbides of the $M_{23}C_6$ and M_6C types, at both inter- and intragranular locations. Microstructural changes that occur during heat treatment are related to contemporary alloys. Progress in alloy development by the British, U. S., and Soviet investigators during the years 1946-1960 is outlined. Chemical compositions and mechanical properties are tabulated for 30 selected alloys. (auth)

2714 (DMIC-154) EVOLUTION OF ULTRAHIGH-STRENGTH, HARDENABLE STEELS FOR SOLID-PROPELLANT ROCKET-MOTOR CASES. H. J. Hucek, A. R. Elsea, and A. M. Hall (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 25, 1961. Contract AF33(616)-7747. 40p. (PB-171423)

The evolution of special steels which are used or are being considered for use in solid-propellant rocket cases and their relationship to the older steels is discussed. The evolution is traced from AISI 4130 through AISI 4340 and its modifications and includes the 5Cr-Mo-V steels (hot-work steels). Tempering, fabrication, welding, notch sensitivity, and other subjects are considered. (D.L.C.)

2715 (DMIC-Memo-42R) STANDARD DESIGNATIONS OF ALLOYS FOR AIRCRAFT AND MISSILES (RE-

VIEWED). J. J. Vagi and A. F. Haskins (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). May 24, 1961. 80p. (PB-161192R).

Tabulations are presented of the trade designations, aeronautical and military specifications, and producers of stainless steel, alloy steel, and superalloys. (B.O.G.)

2716 (DMIC-Memo-110) GLASS FIBER FOR SOLID-PROPELLANT ROCKET-MOTOR CASES. R. J. Runck and B. W. King (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). June 6, 1961. 24p. (PB-171629)

Continuous fibers were produced from glass with considerably higher tensile strength-to-weight ratios than were produced from metals. The availability of such fibers provided a large potential for the development of high strength-to-weight glass-reinforced plastics. In applications such as large rocket-motor cases, glass-reinforced plastics also may have a marked cost advantage over metals. Only moderate improvements in the modulus of elasticity were obtained by modifications in glass compositions or in processing. Marked improvements in the constancy of the properties of glass-reinforced plastics were found to be possible. Rocket-motor cases made with fibers of Type E commercial glass are described. Improvements in strength and constancy of properties of this glass were possible by modified and improved manufacturing processes. The most effective additive to the glass to increase its modulus of elasticity, especially without a proportional increase in density, was beryllium oxide. (auth)

2717 (GEAP-3680) INFORMATION ON THE USE OF BORON CARBIDE AS A NUCLEAR CONTROL AND POISON MATERIAL. E. W. Hoyt (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Mar. 15, 1961. Contract AT(04-3)-189. 22p.

Recent information on boron carbide pertinent to its use as a reactor core material is summarized. Topics discussed include physical and mechanical properties; production; chemical compatibility with water, oxygen, hydrogen, and metals; impurity effects; changes in chemical reactivity with irradiation; helium release; swelling; crystallographic changes; and particle size effects. (M.C.G.)

2718 (HW-65962) A STUDY OF THE WEAR AND GALLING OF AUTOCLAVED ZIRCALOY-2 BY VARIOUS MATERIALS. Interim Report No. 3. J. W. Weber (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 5, 1960. 30p.

Twelve metals and alloys and four grades of graphite were wear tested on autoclaved Zircaloy-2 as prospects for fuel element support-bearing surface materials. Sheffield steel shows a tendency to scratch through the autoclave film on the Zircaloy-2 under conditions approaching point contact unless an oil and water mixture is used as a lubricant. Of the several other alloys tested, including a cast iron, electrolytic iron, vanadium, and low carbon steels, the latter show the best results. Under laboratory testing conditions, 1010 and 1020 plain carbon steels in combination with a proper support surface design do not scratch the autoclaved film of the Zircaloy-2. Graphite bearing surfaces appear favorable from wear considerations but fabrication and attachment are serious problems. There is no indication of galvanic or serious gross corrosion of the Zircaloy-2 in contact with the graphite, cast iron, and low carbon steel. (auth)

2719 (ISC-1176) HALL COEFFICIENT AND RESISTIVITY OF A Mg_2Si SINGLE CRYSTAL FROM 4°K TO 300°K. Donald Richard Zrudsky and G. C. Danielson (Ames Lab., Ames, Iowa). May 1959. 49p.

The Hall coefficient and resistivity of an n-type single crystal of Mg_2Si with a room temperature carrier concentration of $3.5 \times 10^{17} \text{ cm}^{-3}$ was measured at 4.2 to 300°K. The Hall coefficient reached a peak value of $220 \text{ cm}^3/\text{coulomb}$ at a temperature of 17.4°K and a saturation value of $76 \text{ cm}^3/\text{coulomb}$ below a temperature of about 7°K. The Hall mobility of the sample had a temperature dependence of $T^{-2.2}$ at high temperatures and a temperature dependence of $T^{+3.1}$ at low temperatures. The high-temperature measurements confirmed, but added nothing new, some of the work of Morris, Redin, and Danielson. The low-temperature measurements suggest a donor impurity level at 0.0045 eV below the conduction band. The low temperature data seemed to agree self-consistently with a theory of weak impurity-band conduction. On the basis of this theory, a crude estimate of the percentage of acceptor impurities compensated by donor impurities was found to be $50 \pm 25\%$. (auth)

22720 (KAPL-M-MAG-5) EVALUATION OF CHROME COATINGS, ELECTRODEPOSITED ON INCONEL. M. A. Gerardi (Knolls Atomic Power Lab., Schenectady, N. Y.). May 3, 1961. Contract W-31-109-eng-52. 40p.

Chrome coatings electrodeposited on Inconel sleeves were evaluated. The chrome plate was electrodeposited by 4 independent plating sources. Results showed that it is feasible to chrome plate Inconel. Failure to meet thickness requirements, excessive edge buildups, and lack of deposit in certain areas were related to improper racking methods, improper anode design, inadequate use of "thieves," and so forth which can be connected. (auth)

22721 (NAMC-AEL-1674) HIGH STRENGTH REFRACTORY ALLOYS. S. C. Fiorello (Naval Air Material Center, Aeronautical Engine Lab., Philadelphia). Feb. 8, 1961. 30p. (AD-250 741LJ)

Work is being conducted in evaluating high-strength refractory alloys developed at conditions simulating the environments in which the metals might be used. The testing accomplished with the two materials supplied to date by the NRL is summarized. The materials tested are niobium with a zinc coating and niobium plus 2% zirconium with a zinc coating. Both materials were exposed to high-temperature exhaust gases supplied from the combustion of various fuels, hydrogen, propane, and JP-4. The maximum temperature to which the zinc coated materials appeared to perform satisfactorily was less than 1800°F when exposed to the exhaust-gas products of hydrogen, and in the region of 2000 to 2200°F when exposed to the exhaust-gas products of propane and JP-4 fuels. No advantage would be realized by the use of the materials tested in the turbine section of air breathing gas turbine engines, since the current turbine inlet hot spot temperatures are in the same range as the maximum useful temperature determined for these materials. (auth)

22722 (NP-10104) DIELECTRIC AND X-RAY STUDIES OF $\text{Ca}_x\text{Ba}_{1-x}\text{TiO}_3$ AND $\text{Ca}_x\text{Sr}_{1-x}\text{TiO}_3$. Technical Report 162. T. Mitsui and W. B. Westphal (Massachusetts Inst. of Tech., Cambridge. Lab for Insulation Research). Mar. 1961. Contracts AF19(604)-6155 and Nonr-1814(10). 16p.

Ceramics of $\text{Ca}_x\text{Ba}_{1-x}\text{TiO}_3$ and $\text{Ca}_x\text{Sr}_{1-x}\text{TiO}_3$ were prepared, and their dielectric and structural properties investigated. Firing conditions were adjusted to obtain sharp x-ray back reflections. The Curie point of $\text{Ca}_x\text{Ba}_{1-x}\text{TiO}_3$ increases with Ca concentration up to 136°C for $x = 0.08$ and then decreases. Both the tetragonal-orthorhombic and the orthorhombic-rhombohedral transition points of $\text{Ca}_x\text{Ba}_{1-x}\text{TiO}_3$ decrease monotonically with increasing Ca concentration. $\text{Ca}_x\text{Sr}_{1-x}\text{TiO}_3$ solid solutions with $0.01 \leq$

$x \leq 0.10$ are ferroelectric at very low temperatures.

SrTiO_3 assumes a tetragonal structure below about 80°K. (auth)

22723 (NP-10164) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. Progress Report No. 6, January 15 to April 15, 1961. (Manufacturing Labs., Inc., Cambridge, Mass.). Apr. 25, 1961. Contract AF33(616)-6354. 26p.

Completed screening results are presented for 14 promising diffusion couple combinations annealed for 4 hours at 1700°C. Selection of the most promising combinations based on the 1-hour screening tests was revised in order to incorporate the results from the longer annealing time. The W-Re, Ta-Re, and Mo-Ta combinations were added to the previous list of the 12 most promising, and the Mo-Re and Cb-Re combinations were eliminated. Five of the previous 12 were confirmed as most promising based on the results of the 4-hour screening tests. During diffusion annealing the over-all estimated accuracy of temperature control was increased from $\pm 15^\circ\text{C}$ to $\pm 10^\circ\text{C}$ by improving the power control of the induction heater. (auth)

22724 (NP-10211) INVESTIGATION OF REFRACTORY METAL BERYLLIDES AND SILICIDES AS VERY HIGH TEMPERATURE MATERIALS. Progress Report No. 6, Covering January 1, 1961 to March 31, 1961. Technical Report No. 209-222. Jonathan Booker, Robert M. Paine, A. James Stonehouse (Brush Beryllium Co., Cleveland). Apr. 15, 1961. Contract AF-33(616)-6540. 16p.

The study of refractory metal beryllides and silicides for possible applications at very high temperatures, $>2500^\circ\text{F}$, for relatively short periods was continued. Initiation of a study to determine whether an intermediate-temperature problem exists for $\text{Ta}_2\text{Be}_{17}$ or WSi_2 is discussed. Preliminary modulus-of-rupture data for $\text{Ta}_2\text{Be}_{17}$ which contained a slight deficiency of beryllium indicates good strength for this compound over the entire temperature range from room temperature to 2750°F . This is the first in a series of planned experiments to study the effect of stoichiometry upon the properties of $\text{Ta}_2\text{Be}_{17}$ and WSi_2 . Initial studies of the tantalum-beryllium-silicon system in efforts to find new high temperature materials are discussed. (auth)

22725 (NP-10213) THE PRODUCTION OF MATERIALS BASED ON GRAPHITE WITH REDUCED PERMEABILITY AND WITH IMPROVED OXIDATION AND EROSION RESISTANCE. Final Technical Report, August 1, 1959 - July 31, 1960. (Hawker Siddeley Nuclear Power Co., Ltd., Langley, Bucks, England). Nov. 1960. Contract DA-91-591-EUC-1176-OI-1530-59. 44p. (TR-32/1960)

A description is given of an investigation of techniques of impregnating graphite with silicon and titanium to produce a material with reduced permeability and with improved oxidation and erosion resistance. The graphite used for the investigation was Morgan EY9 having a gas permeability of approx $1 \times 10^{-2} \text{ cm}^2/\text{sec}$. For the work on silicon impregnation, the impregnant was silicon tetrachloride, SiCl_4 , and similarly for the work on titanium impregnation the impregnant was TiCl_4 . The impregnation processes were investigated by two techniques, the first being termed "the pressure gradient technique" used to carry out much of the exploratory work and to evaluate the optimum conditions for impregnation. In this process, an atmosphere of argon containing impregnant vapor was continually drawn through heated graphite by imposing a pressure gradient through the graphite. The second process was termed the "diffusion technique," in which experiments were carried out without the influence of a pressure gradient in the graphite, relying

diffusion alone to bring the impregnants into contact with the graphite. (auth)

2726 (NP-10219) INVESTIGATIONS OF BISMUTH-TELLURIUM-SULFUR COMPOUNDS. Final Report. Report No. 2195. H. H. Soonpaa and R. K. Mueller (General Mills, Inc., Minneapolis). May 15, 1961. 80p.

A new semiconducting crystalline compound— $\text{Bi}_2\text{Te}_3\text{S}_5$, or gemilide—was prepared. The material is characterized by rhombohedral $R\bar{3}m$ symmetry, a large unit cell where $a = 8.3935\text{\AA}$ and $c = 58.904\text{\AA}$ by hexagonal notation. It cleaves readily along the base plane, perpendicular to the c -axis, to yield mirror-like surfaces. The purity of the material is adequate to allow optical transmission measurements. The index of refraction in the infrared is around 2.5, decreasing linearly with the wavelength. Electrical and optical measurements yield the following physical constants for a sample with a carrier concentration of $n = 3.5 \times 10^{19} \text{ cm}^{-3}$: $\sigma_{||} = 1.75 \times 10^3 \text{ ohm}^{-1} \text{ cm}^{-1}$; $\sigma_{||}/\sigma_{\perp} = 6.4$; $\mu_{H||} = 11 \times 10^2 \text{ cm}^2/\text{volt-sec}$; $K_{||} = 3.17 \times 10^{-2} \text{ watts/cm}^2\text{K}$; $\alpha = 0.16 \text{ mV/}^\circ\text{C}$; $\tau_{||} = 2.8 \times 10^{-14} \text{ sec}$; and $E_G = 0.40 \text{ eV}$ at room temperature. The subscripts $||$ and \perp refer to the cleavage plane. Different measuring techniques are described. A new method of determining electrical conductivity anisotropy tensors of thin slabs of material is discussed. The mathematical derivation is included. The Lorenz number is low for the material, as expected from the large unit cell. A lattice, with a long range periodicity is expected to act as a waveguide tuned to electrons and detuned for thermal planes. With an improved Seebeck coefficient gemilide might be a good thermoelectric material. (auth)

2727 (NP-10221) INVESTIGATION OF SINTERABLE POWDERS AND CERAMICS MADE FROM THEM. First Quarterly Report. C. Hyde, M. J. Snyder, and W. H. Duckworth (Battelle Memorial Inst., Columbus, Ohio). May 15, 1961. Contract AF33(616)-7733. 10p.

To improve experimental control, it was determined advisable to calcine in an electrically heated furnace rather than the gas-fired furnace used previously. In addition, the basic magnesium carbonate was calcined in narrow saggars rather than in the crucibles. This increased the amount of powder calcined at one time, and, it is believed, improved its uniformity. The changes in experimental procedures introduced during the period had an unexpected effect on the interability of the powder formed. The relation between calcining temperatures and sintered density did not have the sharp peaks previously reported. The optimum calcining temperature apparently shifted from 1100 to 1400°F under the revised conditions. The ceiling density was decreased from about 97.5 to 97.0% of theoretical, and the temperature at which this density was attained was increased from 2400 to 2600°F. From differential thermal analysis and thermogravimetric analysis of AR-grade basic magnesium carbonate, the most sinterable powders appear to be formed above the temperature of the last reaction as indicated by DTA but in the range where 1 to 5% of volatile material remains as indicated by TGA. (auth)

2728 (NP-10231) THE INFLUENCE OF SURFACE CONDITION AND CHEMICAL ENVIRONMENT ON DEFORMATION AND FRACTURE PROCESSES IN CERAMICS. Progress Report No. 4. R. F. Schneidmiller, E. C. Supan, and J. F. Young (Douglas Aircraft Co., Inc., Santa Monica, Calif.). May 15, 1961. Contract AF33(616)-7315. 21p.

Work for the quarter was primarily involved in electron microscopy studies of surface effects on MgO crystals heat treated and manipulated in closely controlled atmospheres. Supplementary work included determination of the crystal-

lographic "d" value of the heat-treated MgO specimens by x-ray diffraction techniques. Additional electron microscope studies were concerned with MgO crystal surfaces etched in aqueous solutions. Precise measurements of x-ray d values were made on crystals from the various heat treatments as an indication of effect on the bulk properties of the crystal. The results of these measurements are tabulated. (auth)

2729 (NP-10318) THE DEVELOPMENT OF CREEP RESISTING ALLOYS OF ZIRCONIUM AS STRUCTURAL MATERIALS FOR USE IN THE CORES OF NUCLEAR REACTORS. PART I. N. L. Parr and C. Judge (Gt. Brit. Admiralty Materials Lab., Poole, Dorset, England). Mar. 1955. 29p. (AML-A/67(S))

Binary and ternary alloys of zirconium were investigated for physical construction and associated creep strength as potential structural materials for nuclear reactors. Preliminary creep results were considerably improved by thermal treatment of the alloys. Work proceeding on Zr, Zr-Mo, Zr-Mo-Ti, Zr-Sn, Zr-Al, and Zr-Nb alloys is described. Results suggested that improvement in creep strength is obtained by over-aging rather than by conditions giving maximum room temperature hardness. Other properties of the alloys determined during the course of the investigation are included. (auth)

2730 (NP-10319) THE DEVELOPMENT OF CREEP RESISTING ALLOYS OF ZIRCONIUM AS STRUCTURAL MATERIALS FOR USE IN THE CORES OF NUCLEAR REACTORS. PART II. C. Judge and L. Wortley (Gt. Brit. Admiralty Materials Lab., Poole, Dorset, England). July 1955. 34p. (AML-A/68(S))

The study and development of the Mo-Zr, Mo-Ti-Zr, Sn-Zr, Al-Zr, and Nb-Zr alloys continued with observation of the effect of composition and thermal treatment on creep properties at 300, 450, and 600°C. Significant improvements were effected on each alloy by structural modifications. (auth)

2731 (NP-10320) THE DEVELOPMENT OF CREEP RESISTING ALLOYS OF ZIRCONIUM AS STRUCTURAL MATERIALS FOR USE IN THE CORES OF NUCLEAR REACTORS. PART III. C. Judge and D. Healey (Gt. Brit. Admiralty Materials Lab., Poole, Dorset, England). Sept. 1956. 35p. (AML-A/70(S))

Investigation and development of binary and ternary creep resisting alloys of zirconium continued. Most of the data presented were obtained at 300 and 450°C., and improvements achieved by thermal treatments led to the adoption of higher stress levels. Some further data at 600°C. are also given. Creep tests in air at 300°C. revealed that the binary tin alloys, Zircalloys, and niobium compositions have unexpected oxidation resistance at this temperature. (auth)

2732 (NP-10321) SOME PROPERTIES OF GRAPHITE-MELTED ZIRCONIUM ALLOYS. PART I. A SURVEY OF RESULTS OBTAINED UP TO THE END OF 1960. C. Judge (Gt. Brit. Admiralty Materials Lab., Poole, Dorset, England). May 1961. 14p. (AML-A/80(S))

Presented is a digest of the work carried out to produce creep-resistant alloys of zirconium. Compositions having promising tensile properties, creep strength, and oxidation resistance up to 450°C were produced. (auth)

2733 (NP-10322) STUDY OF COMBINATIONS OF HIGH AND LOW ELASTIC MODULUS CERAMIC MATERIALS. Quarterly Report No. 5, March 15, 1960 through June 15, 1961. Peter T. B. Shaffer and Dick P. H. Hasselman (Carborundum Co. Research and Development Div.,

Niagara Falls, N. Y.). June 15, 1961. Contract AF33(616)-6806. 32p.

Mechanical and thermal properties were measured for composite bodies of ZrC-graphite and $\text{Al}_2\text{O}_3\text{-ZrO}_2$. Thermal shock tests were also carried out on these bodies. The changes in the fracture behavior of the high Young's modulus phase on additions of the low Young's modulus dispersed phase were observed. Transient thermal stresses in spherical bodies subjected to thermal shock were calculated. (D.L.C.)

22734 (NP-10323) ENGINEERING PROPERTIES OF POTASSIUM; FIRST QUARTERLY REPORT, COVERING PERIOD OCTOBER 1 THROUGH DECEMBER 31, 1960.

Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 30, 1961. Contract NAS 5-584. 22p.

In the current program for determining the engineering properties of potassium all items of the program are in the equipment planning and construction phase. It was decided that Nb-1% Zr alloy will be used for all items of apparatus in contact with potassium at temperatures up to 2100°F. Stainless steel may be used below 1600°F. Transpiration and boiling point apparatus are being readied for use in determination of vapor pressure. Design of a steady-state longitudinal-heat-flow apparatus for the determination of liquid thermal conductivity is under way. The oscillating-cylinder method for measuring liquid viscosity was selected as the one most readily adaptable to liquid potassium. (M.C.G.)

22735 (NP-10324) ENGINEERING PROPERTIES OF POTASSIUM; SECOND QUARTERLY REPORT, COVERING PERIOD, JANUARY 1 THROUGH MARCH 31, 1961.

Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Apr. 30, 1961. Contract NAS 5-584. 20p.

The program for determining the engineering properties of potassium was initiated and equipment is being planned and built. Limited experience with Type 347 stainless steel up to 1432°F verified the usefulness of this material with potassium. It was found that a mullite tube was not satisfactory for exposure to potassium vapor at temperatures of about 550°C. The transpiration apparatus for the measurement of the density of potassium vapor was estimated to have an error of about 1% at a vapor pressure of 200 mm Hg. Boiling point experiments yielded preliminary values for the vapor pressure of potassium between 966 and 1432°F. Fabrication of the steady-state longitudinal-heat-flow apparatus for the determination of the liquid thermal conductivity of potassium is underway. Construction of the oscillating-cylinder viscometer is in progress. It was decided that a constant-volume system would be best for the determination of P-V-T properties. (M.C.G.)

22736 (NP-10351) A STUDY OF THE INFLUENCE OF HEAT TREATMENT ON MICRO-STRUCTURE AND PROPERTIES OF REFRACTORY ALLOYS. Quarterly Report No. 5 [for] March 1, 1961 to May 31, 1961. W. H. Chang (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Contract AF 33(616)-7125. 37p. (DM61-191)

The studies on Mo-base alloys were completed with the determination of strength properties of heat-treated but non-worked Mo-TZC and Mo-TZ. The results showed that at the appropriate temperatures, the tensile and rupture strengths of the annealed conditions can approach or even exceed those of the worked condition. This was made possible primarily by a fine, strain-induced precipitation which greatly enhanced the rate of strain hardening of the annealed conditions during test. Strain-induced ageing was confirmed by microstructural examination as well as temperature and strain-rate dependencies. The annealed conditions show re-

versed temperature dependency and negative strain-rate sensitivity. The solutioning and ageing reactions of the Nb-base alloys F-48 and F-50 were investigated. In the presence of the interstitial contents, both alloys are typically precipitation-hardenable based on the changes in hardness and microstructure and incomplete phase-identification results. The F-48 alloy age-hardened extensively in the temperature range of 1800° to 2100°F, whereas the optimum ageing temperature range of F-50 was found to be 200° to 300°F lower. The lower solutioning and ageing temperature ranges of F-50 appeared to result primarily from the Ti addition rather than its lower interstitial contents. (auth)

22737 (NP-10357) SOME ASPECTS OF STRESS CORROSION CRACKING IN AUSTENITIC STAINLESS STEELS. Technical Report No. 3. D. Van Rooyen (Westinghouse Electric Corp. Research Labs., Pittsburgh). Aug. 25, 1960. 46p.

The addition of small amounts of nitrogen, or larger amounts of molybdenum reduced the resistance of austenitic stainless steels to transgranular stress corrosion cracking. Increasing the carbon or nickel contents, and perhaps tin to some extent, made the alloys more resistant to cracking. These variations in time to failure resulted from differences in reaction time preceding crack propagation, while the rate of crack penetration remained approximately constant. Composite stress corrosion samples were made in which the test alloys were bonded to a steel which was susceptible to cracking. Results showed that there was good correlation between the times to failure of the experimental alloys when tested alone, and the number of propagating cracks which will penetrate into them. The possibility is suggested that crack initiation consists of a form of corrosion attack which is required to expose a path of rapid corrosion, after which true cracking proceeds. Potential measurements indicated that strain-induced anodic depolarization cannot account for cracking entirely by an electrochemical mechanism. Preference was given to an electrochemical mechanism wherein reaction takes place at sites of structural and composition changes in the steels. These may be formed under the influence of stress, setting up paths of easy localized corrosion. (auth)

22738 (NYO-6435) A STUDY OF INCLUSIONS IN URANIUM. George L. Kehl and Eric Mendel (Columbia Univ., New York). Nov. 25, 1959. Contract AT-30-1-1593. 26p. (CU-1-59-AT-1593 Met.)

A study was made of the UO inclusion in uranium and the attendant rim surrounding it. Specimens of the material containing a variety of sizes of the UO inclusions were prepared metallographically for the preservation of the inclusions. In order to preserve the specimen surface during heat treatment, procedures were developed for encapsulating the specimen with an inert atmosphere. After encapsulation, the specimens were heat treated in an air furnace at 800 to 810°C for times varying from 24 to 2500 hr. Results indicated that the diffusion layer observed on the surface after heat treatment and repolishing is quite representative of what is occurring bulk-wise. No significant diffusion occurred between the inclusion and rim, or inclusion and matrix, up to 46 hr. However, between 46 and 135 hr the process started. For a given time the rims created in the regions where none originally existed were of the same thickness as the growth of the existing rims. Data indicated that the diffusion rates within the UO inclusion-rim complex are comparatively slow at 810°C, although what diffusion that does occur is reflected in significant changes in some properties of the UO core. Preliminary data on UO_2 inclusions surrounded by U(C,N) intermediate phase are reported. (M.C.G.)

739 (R60FPD358-A) THERMODYNAMIC PROPERTIES OF ALKALI METAL VAPORS AND MERCURY. C. J. Eisl. Revised by A. Shapiro (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Second Revision, Nov. 9, 1960. 179p.

The thermodynamic properties of Na, K, Rb, Cs, Hg, and Li are presented for the saturated liquid, saturated vapor, and superheated vapor phases as a function of temperature. The following properties are included: enthalpy, entropy, molecular weight, specific volume, equilibrium sonic velocity, frozen sonic velocity, equilibrium specific heat, frozen specific heat, and frozen isentropic exponent. (th)

740 (RISO-25) THE EFFECT OF HEAT TREATMENTS ON THE STRUCTURAL STABILITY OF SINTERED ALUMINUM PRODUCTS. Niels Hansen and Eivind Adolphsen. Atomenergikommissionen. Forsøgsinstitut, Copenhagen. May 1961. 39p.

The structural stability of the sintered aluminum powder product (SAP) at elevated temperatures was investigated. Heat treatment in air of SAP resulted in formation of blisters at 610°C and above, and formation of fissures in the microstructure at 500°C and above. In creep specimens, blisters were observed at 400°C and above. The periods of testing ranged from a few minutes to hundreds of hours. The formation of blisters and fissures in SAP was due to hydrogen in the material, and different methods of reducing its hydrogen content are proposed. One of the suggested methods is vacuum heat treatment of SAP in the fabricated state, carried out at 600°C for periods of 4 to 120 hours. The vacuum treatment was followed by heat treatment in air or vacuum in the temperature range from 500° to 600°C, and no formation of blisters and/or fissures was observed after extended periods of heating. The vacuum heat treatment of SAP was followed by gas analyses which showed that the hydrogen content of the material was reduced by a factor of 2 to 10 to about 10ppm for vacuum treated SAP independent of initial gas content. (auth)

741 (TID-12948) DIFFUSION IN METALS. Progress Report and Publication List. David Lazarus (Illinois Univ., Urbana). June 15, 1961. Contract AT-(11-1)-67. 10p.

Discussions are presented of studies conducted in tracer diffusion, high-pressure effects on metals, anelastic relaxation, resistivity, nuclear magnetic resonance, and the theory of vacancies and complexes in noble metals. (B.O.G.)

742 (TID-13035) STRESS AND STRESS ANISOTROPY IN IRON FILMS. Technical Report No. 18 [on] SOLID STATE PHYSICS PROGRAM. J. D. Finegan and W. Hoffman (Case Inst. of Tech., Cleveland). May 1961. Contract AT(11-1)-623. 57p.

Measurements were made of the angle of incidence and thickness dependence of the stress anisotropy and stress in iron films. The angle of incidence was varied from 0° to 36.5° in films of a nominal thickness of about 650Å. The ratio of the minimum stress to maximum stress varied from 1 for normal incidence to about 0.85 for a 36.5° angle. The direction of maximum stress was normal to the plane of incidence of the depositing atoms. At an angle of incidence of 36.5° the film thickness was varied from 216Å to 33Å. The stress ratio decreased from 0.94 at 216Å to about 0.84 at 700Å and then increased to 0.89 at 1033Å. The stress of about 10^{10} (dynes/cm²) decreased with increasing thickness except for a narrow and pronounced peak at about 700Å. The essential features are given for an explanation of the stress in terms of the mismatch of the crystallographic structure at grain boundaries. (auth)

22743 (TID-13054) FIELD DEPENDENCE OF PHOTOELECTRIC EMISSION FROM MOLYBDENUM. R. C. Jaklevic and D. W. Juenker (University of Notre Dame; Notre Dame, Ind.). [1960]. Contract AT(11-1)-274. 26p.

Photoelectric emission from a 5-mil Mo single crystal wire was measured at 1000°K with accelerating fields at 0.8 to 142 kv/cm and monochromatic light at 238 to 297 mμ. A multiplicity of apparent work functions obtained in measurements on a single specimen and the marked dissimilarity in the emission constants found in sheet and wire form are explained in terms of patch effect. The theory for the periodic deviation from the photoelectric Schottky effect is extended to describe emitters at elevated temperatures. No evidence for the predicted deviation appears in the experimental photoelectric Schottky data. (auth)

22744 (TID-13055) TRIURANIUM HEPTAOXIDES: HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF α- AND β-U₃O₇ FROM 5 TO 350°K. Edgar F. Westrum, Jr. (Michigan Univ., Ann Arbor) and Fredrik Grønvald (Oslo. Universitetet. Kjemisk Institutt). [1960]. 42p.

Low temperature heat capacities were measured by adiabatic calorimetry on two phases with composition UO_{2.33} designated as α and β-U₃O₇. These data were correlated with structural and magnetic properties and thermodynamic data for other oxides. Results are included. (J.R.D.)

22745 (TID-13058) A STUDY OF THE KINETICS OF TRANSFORMATION OF NIOBIUM-BASE, ZIRCONIUM ALLOYS. Monthly Letter Report No. 13, May 1, 1961 to June 1, 1961. Charles E. Lundin and Ronald H. Cox (Denver Univ. Denver Research Inst.). June 13, 1961. Contract AT(11-1)-752. 7p.

A program is described in which the transformation phenomena of pure Nb and five selected alloys ranging in composition from 9.6 to 21 wt % Zr are being studied. Development of a vacuum recrystallization furnace for use in production of homogeneous rod-shaped specimens for resistivity tests is reported. Fabrication techniques and design of the furnace are discussed. Recrystallization of 9.6, 18.4, and 21 wt % Zr alloys at 1700°C for 15 minutes is reported. (J.R.D.)

22746 (UNM-PR-EE-28) SURFACE STUDIES ON REDUCED TITANIUM DIOXIDE INVOLVING INJECTION REAGENTS AND CONTACT FORMING. Richard Bechtel, Goebel Davis, Jr., W. W. Grannemann, and Harold Barnett (New Mexico Univ., Albuquerque. Engineering Experiment Station). May 1961. For Sandia Corp. 23p. (SCDC-2345)

Investigations were made of reduced TiO₂ rutile in the following areas: tests for contact injection, surface studies of breakdown phenomena, reagent studies, saturation-breakdown characteristics, ohmic contact consistency, least squares fitting of the diode characteristics, and an oil immersion test. Results are presented in graphs and tables. (M.C.G.)

22747 (WADC-TR-57-374(Pt.VI)) PHYSICAL PROPERTIES OF HIGH TEMPERATURE MATERIALS. PART VI. ENTHALPY AND HEAT CAPACITY OF MAGNESIUM OXIDE, ZIRCONIUM OXIDE, AND ZIRCONIUM SILICATE FROM 0° TO 900°C. Andrew C. Victor and Thomas B. Douglas (National Bureau of Standards, Washington, D. C.). July 30, 1960. Contract AF33(616)-5621. 16p.

The heat contents of three refractory substances, magnesium oxide, zirconium oxide, and zirconium silicate, were measured relative to 0°C at 100-degree intervals up to 900°C with a precise "drop" calorimetric method. The magnesium oxide sample was of high purity; the other

samples, however, were of relatively low purity. The derived specific heats can be described by the following equations in calories per gram-deg C at $t^{\circ}\text{C}$: (170 to 900°C) MgO : $C_p = 0.2889 + 2.94(10^{-5})t - 6.31(10^3)/(t + 273.15)^2$; (0 to 900°C) ZrO_2 : $C_p = 0.1524 + 2.98(10^{-5})t - 10.633/(t + 273.15)$; and (0 to 900°C) ZrSiO_4 : $C_p = 0.17945 + 2.41(10^{-5})t - 4.598(10^3)/(t + 273.15)^2$. The specific heats from these equations are compared with values from the literature. (auth)

22748 (WADD-TR-60-403) DEVELOPMENT OF RANDOMLY ORIENTED WROUGHT BERYLLIUM SHEET.

F. M. Yans, A. K. Wolff, and A. R. Kaufmann (Nuclear Metals, Inc., Concord, Mass.). Sept. 8, 1960. Contract AF33(616)-6616. 93p.

Various factors affecting texture development in beryllium were studied in an effort to produce randomly oriented wrought beryllium sheet. Rolling experiments indicated that the specimen geometry and rolling sequence affected the textures developed during working. It was determined that, during rolling, the basal plane population parallel to the plane of the sheet increased with reduction in area and, when certain specimens are heat treated at high temperatures for short times, the basal plane population parallel to the plane of the sheet is reduced. Further rolling and annealing studies performed on bi-directionally rolled sheet indicated that, when the sheet is subjected to annealing temperatures in excess of 950°C , the location of the basal plane peak intensity is shifted and the intensity profile changes considerably, yielding a third-dimensional ductility of 1.75%. The same sheet in only the stress-relieved condition possesses only 0.2% third-dimensional ductility. The same textural changes were observed in sheet samples manufactured by compression rolling. (auth)

22749 (WADD-TR-60-793) DIFFUSION IN REFRACTORY METALS. N. L. Peterson (Advanced Metals Research Corp., Somerville, Mass.). Dec. 1, 1960. Contract AF33(616)-7382. 164p.

Data available in the open literature on diffusion in tungsten, tantalum, molybdenum, niobium, platinum, hafnium, zirconium, vanadium, chromium, and titanium are reviewed and evaluated. Information on ninety-five binary systems and thirteen ternary or higher order systems is reported. (auth)

22750 (AEC-tr-4061(p.199-219)) PHASE DIAGRAMS OF TITANIUM-LANTHANUM AND TITANIUM-CERIUM ALLOYS. E. M. Savitskii and G. S. Burkhanov. Translated from Zhur. Neorg. Khim., 2: 2609-16(1957).

The influence of La and Ce on the structure and properties of Ti was investigated. La and Ce were found to stabilize the α phase of Ti by raising the polymorphic transformation temperature and to form limited solid solutions with Ti. A peritectoid reaction of the type $\beta + \gamma \rightleftharpoons \alpha$ was found to take place in the Ti-La and Ti-Ce systems. Non-variant equilibrium is established at 1520°C in Ti-La and at 1450°C in Ti-Ce. Small additions of La and Ce to Ti were found to make the structure of the alloys much finer and to increase the hardness. (D.L.C.)

22751 (AEC-tr-4637) CAUSE AND ESTABLISHMENT OF THE ANOMALOUS STRUCTURE IN STEELS. (DISCUSSION AND CONCLUSIONS). H. J. Wiester, R. Pusch, and M. Hoffmann. Translated for Oak Ridge National Lab. from Arch. Eisenhüttenw., 31: 743-5(Dec. 1960). 12p.

The effects of various foreign and alloying elements in steel on the formation of structural anomalies was determined with the use of pure hyper-eutectoid iron-carbon alloys. It was found that additions of Mn, Si, Al, and As

counteract such anomalies which are characteristic of C-Fe systems. O, P, and Cu favor it to a certain extent, while S and N have no effect. (J.R.D.)

22752 (AEC-tr-4653) HETEROTYPE MIXED PHASES IN RARE EARTH OXIDES. [PART] I. G. Brauer and H. Gradinger. Translated from Z. anorg. u. allgem. Chem. 276: 209-26(1954). 28p.

From a comparative consideration of the structure in the lattice types of CaF_2 , Mn_2O_3 , and La_2O_3 it was assumed that between oxides which crystallize in the fluorite type and others which crystallize in the Mn_2O_3 type, although they have different formula types under certain suitable conditions, a continual series of mixed crystals must exist. To prove this assumption the complete phase diagrams in the binary oxide systems CeO_2 - Y_2O_3 , CeO_2 - Nd_2O_3 , CeO_2 - Sm_2O_3 , CeO_2 - Gd_2O_3 , CeO_2 - Dy_2O_3 , CeO_2 - Yb_2O_3 , ThO_2 - Y_2O_3 , ThO_2 - La_2O_3 , ThO_2 - Ce_2O_3 , ThO_2 - Nd_2O_3 , ThO_2 - Sm_2O_3 , and ThO_2 - Gd_2O_3 were drawn up through preparation, and x-ray and pycnometric investigations. In the four systems with CeO_2 and Y_2O_3 , Sm_2O_3 , Gd_2O_3 , or Dy_2O_3 , the continuous transition between the components was found. In all the remaining systems only a limited mixed crystal series with the fluorite structure existed. Explanations are given and rules formulated for the appearance of one or another type in the phase behavior of the systems. (auth)

22753 (JPRS-9473) METALLURGY AND METALLOGRAPHY OF PURE METALS. V. S. Emel'yanov (Yemel'yanov) and A. I. Evstyukhin (Yevstyukhin), eds. Translation of "Metallurgiya i Metallovedenie Chistyykh Metallov" (A publication of Atomizdat, Moscow, 1960). 395p.

Twenty-seven reports presented at scientific conferences by instructors of Moscow Engineering-Physical Institute in 1957 and 1958 are given. These articles are devoted to a study of the production methods and properties of the pure metals and their alloys used in the new branches of technology. Topics covered include: the iodide method of refining thorium and chromium, iodide zirconium and certain of its properties, apparatus for measuring the vapor pressure of zirconium and hafnium chlorides and iodides, investigations of alloys of Zr-Al-Be, corrosion stability of steel in lithium with impurities of oxygen and nitrogen, the influence of alloying on the protective properties and critical thickness of the oxide film on zirconium, physical and mechanical properties of zirconium and its alloys, distribution and electrodiffusion of tin in alloys of zirconium, electrodiffusion of carbon in zirconium, the influence of the structural factor on diffusion in zirconium and its alloys, determination of heats of sublimation of silver, nickel, and zirconium by the method of radioactive tracers, producing alloys of zirconium with small amounts of nitrogen and oxygen, technology of lithium and its industrial utilization, vacuum distillation of lithium, solubility of metals in lithium, corrosion of iron and chromium steels in liquid lithium, internal friction of metals and alloys, temperature dependence of internal friction and modulus of elasticity of zirconium, niobium, and their alloys, temperature dependence of the internal friction and modulus of rigidity of uranium, distribution of carbon in stainless steels, autoradiographic studies of the distribution of sulfur and phosphorus in steel, the influence of alloying on the diffusion of elements in chromium-nickel steels, use of radioisotopes in a study of the influence of structure on diffusion in steels and alloys, redistribution of sulfur during zone fusion of chromium in an arc furnace, metallurgy of rare earth metals, and the production and use of beryllium. (M.C.G.)

2754 (NP-tr-612(p.12-36)) RATE OF DIFFUSION OF HYDROGEN IN STEELS AT HIGH TEMPERATURES. A. Ryabov and P. V. Gel'd. Translated from p.147-56 "Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovanii, 1956," Moscow, 1959. The results of investigations of the rate of diffusion of hydrogen in steels and alloys at elevated temperatures (500 to 1000°C) are given. The rate of diffusion at a given temperature was determined by the quantity of hydrogen diffused during a unit of time through a unit plane of specific thickness under the influence of a certain drop in pressure. The diffusion block consisted of a case, specimen, end-to-end coolers, and an oven. In steel, the rate of diffusion in the α phase was considerably higher than in the β phase (when extrapolated to identical temperatures). The energy of activation of the diffusion process in the α phase of the steels studied had a value lying in the range of $E = 8,000$ to $20,000$ cal/mole. The rates of diffusion were found to decrease regularly with an increase in carbon concentration in the steel. The presence of chromium up to 12% caused a sharp decrease in the rate of penetration and an increase in the energy of activation. A further increase in chromium content in the alloy (up to 28%) did not change the rate of diffusion and energy of activation. Vanadium had very little effect on the diffusion rate. Silicon and manganese markedly decreased the rate of diffusion of hydrogen in iron. However, the energy of activation in this case increased insignificantly. The influence of the dissolution of austenite on the rate of diffusion of hydrogen in steel is shown in graphs. The rate of diffusion varied with pressure according to the square root law. (M.C.G.)

2755 (NP-tr-612(p.37-67)) ON THE PHASE DIAGRAM OF THE "CHROMIUM NIOBIUM" SYSTEM. V. N. Yermenko (Yermenko), G. V. Zudilova, and L. A. Gayevskaya. Translated from p.224-36 of "Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovanii, 1956," Moscow, 1959. The structure of alloys in the chromium-niobium system was investigated by thermic, metallographic, and radiographic analysis and measurements. It was found that one metal compound of the NbCr_2 composition, having a face-centered cubic lattice, is formed in the system. The metal compounds formed eutectics with solid solutions on a chromium base and on a niobium base. The temperature of the eutectic crystallization of the intermetallic substance with a solid solution on a chromium base was $1,660^\circ\text{C}$, while the eutectic composition was close to 31 wt. % niobium. The eutectic of the metal compound with the solid solution on a niobium base crystallized at $1,710^\circ\text{C}$, and the eutectic composition had 66 wt. % niobium. Prolonged annealing at $1,350^\circ\text{C}$ enlarged the constituents of the eutectic. After 100 hr annealing at $1,350^\circ\text{C}$, the eutectic structure disappeared. The results of the studies made it possible to outline the chromium-niobium system phase diagram. (M.C.G.)

2756 (NP-tr-616) THE EFFECT OF SEPARATE ALLOYING ELEMENTS ON THE HEAT RESISTANCE OF METALS. P. B. Mikhailov-Mikheev (Mikhailov-Mikheyev). Translated from pages 135-76 of "Metall Gazovyykh Turbin," 1958. 70p.

Studies were made of the effect of separate alloying elements on the heat resistance of metals. The effects of C, Al, Cr, Co, W, Mo, V, Ti, Nb, Al, Si, Mn, N, B, and the rare earth metals were investigated. (M.C.G.)

2757 (NP-tr-620) TERNARY METAL COMPOUNDS. V. K. Vul'f. Translated from Uspekhi Khim, 29: 774-85 (1960). 51p.

Ternary phases which are characterized in their diagrams of state by areas of homogeneity limited on all sides and degenerating into points when they lack the power to dissolve excess components were studied. Particular attention was given to the ternary phases which are continuous solid solutions between two binary metal compounds, because they show superstructural lines in x rays and manifest particular properties different from those worked out according to the additivity principle. General features of ternary metal compounds, ternary Kurnakov phases, valent ternary metal compounds, electronic ternary compounds, ternary Laves phases, ternary nickel-arsenide phases, interstitial phases, and properties and practical applications of ternary metal compounds are discussed. (M.C.G.)

22758 (NP-tr-621) STUDY OF THE STRUCTURE OF METALS BY THE METHOD OF RADIOACTIVE ISOTOPES (SELECTED CHAPTERS). S. Z. Bokshteyn, S. T. Kishkin, and L. M. Moroz. Translated from p.95-193 of "Issledovaniye Stroyeniya Metallov Metodam Radioaktivnykh Izotopov" (A publication of the State Publishing House of Defense Industry, Moscow, 1959). 143p.

A method for the qualitative and quantitative investigations of the dispersion of elements in alloys and the diffusion of the components in the volume and along the grain boundaries was developed which took into consideration the use of radioisotopes. The accepted method of investigation included qualitative autoradiography, quantitative autoradiography, and the study of movement along the grain boundaries. The selection of the radioisotopes and the preparation of the alloys is described. A method of contrasting autoradiography was developed. The distribution of different impurities (P, S, Sn, and Cr) in iron and nickel alloys was determined with the help of radioisotopes. Studies were also made of the distributions of W, Mo, Nb, Zr, and Fe in nickel and its alloys. The effects of heat treatment on the redistribution of the elements and also on the variability of the inhomogeneity of the alloys were investigated by autoradiographic methods. A study of the influence of hot-working on the processes of redistribution of the concentration of the alloying elements was carried out. With the help of the radioisotope method, studies were made of the character of the self-diffusion of Sn, Fe, and Cr, and also the diffusion of these elements in Ti, Cr, Fe, Co, Ni, Cu, Sn, and in Ni alloys. (M.C.G.)

22759 (NP-tr-622) THERMOPHYSICAL PROPERTIES OF MATERIALS (SELECTED PARTS). V. S. Chirkdn. Translated from Teplofizicheskiye Svoystva Materialov, Spravochnoye Rukovodstvo, Moscow, p.6-10; 172-248; 248-346, 1959. 169p.

Tables of thermophysical properties are presented for a variety of substances, including gases, liquids, metals, and building and insulation materials. The tabulated properties include such properties as melting and boiling points, enthalpy, specific heat, thermal conductivity, specific gravity, viscosity, etc., and are for temperatures above 0°C . (D.L.C.)

22760 (NP-tr-652) NON-EQUILIBRIUM STATE AND DIFFUSION CREEP IN CERAMET BODIES. B. Ya. Pines and A. F. Sirenko. Translated from Fiz. Metal. i Metalloved., 8: 766-76(1959). 34p.

A review of diffusion creep in powder metallurgical bodies is presented. It is noted that diffusion creep in such bodies under tension is considerably retarded by preliminary annealing, however cold working intensifies creep. In mixtures of reacting metal powders the initial creep rate increases in relation to the appearance of excess vacancies

in the process of hetero-diffusion. The activation energy for creep is smaller than the activation energy for self-diffusion, and it increases with the increase of duration and temperature of annealing. (J.R.D.)

22761 (NP-tr-654) A UNIFIED STATISTICAL THEORY OF STRENGTH OF SOLID BODIES. S. D. Volkov. Translated from Zhur. Tekh. Fiz., 23: 2025-37(1953). 39p.

Work was conducted to develop a unified theory of strength which can be used both in the mechanism of fracture and to derive a single set of conditions of strength which will fit all stress states. Examinations were made of various inadequate technical theories of strength as well as the possibility of applying statistical mechanics to create a more general theory. (auth)

22762 (UCRL-Trans-661(L)) STUDY OF THE MECHANISM OF THE HYDROGEN BRITTLINESS OF TITANIUM AND ITS ALLOYS. L. S. Moroz and Yu. D. Khesin. Translated from Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk, Met. i Toplivo, No. 1, 111-22(1960). 34p.

A study of the effects of hydrogen on the mechanical properties of titanium alloys was conducted using two-phase alloys containing 2% Mn-1.3% Fe-0.8% Cr-1.2% Mo-1.2% V, and 5% Al-3% Mo-3% V, and a β -phase alloy with 15% Mo. The hydrogenation of the specimens was carried out by electrolytic and high-temperature methods. Results of x-ray examinations, electron microscopy studies, and tensile tests were tabulated. (B.O.G.)

22763 TEMPERATURE DIFFUSE SCATTERING FOR CUBIC POWDER PATTERNS. Bernard Borie (Oak Ridge National Lab., Tenn.). Acta Cryst., 14: 566-8(June 10, 1961). (In English)

General expressions for the various orders of temperature diffuse scattering (TDS) for cubic elements are developed which show that the diffuse peaks at the Bragg maxima are broader for the higher order TDS contributions, and which also show that the average value of l th order TDS (in electron units per atom) is $f^2 \exp[-2M(2M)^{1/2}l]$. The relevance of this result to the Warren theory and the more recent Paskin theory for TDS for cubic powders is discussed, and it is shown that the Warren theory is more accurate. (auth)

22764 MIXED OXIDES OF TITANIUM AND NIOBIUM. [PART] I. A. D. Wadsley (C.S.I.R.O. Chemical Research Labs., Melbourne). Acta Cryst., 14: 660-4(June 10, 1961). (In English)

TiNb₂O₇ crystallizes as monoclinic needles, space group A2/m, and with the unit-cell dimensions $a = 11.93$, $b = 3.81$, $c = 20.44$ Å; $\beta = 120^\circ 10'$. The structure, solved by a trial-and-error procedure and then refined by Fourier methods, contains a random distribution of both Ti and Nb in the metal positions of an octahedral structure of a new kind. (auth)

22765 MIXED OXIDES OF TITANIUM AND NIOBIUM. II. THE CRYSTAL STRUCTURES OF THE DIMORPHIC FORMS OF Ti₂Nb₁₀O₂₉. A. D. Wadsley (C.S.I.R.O. Chemical Research Labs., Melbourne). Acta Cryst., 14: 664-70(June 10, 1961). (In English)

The structure of orthorhombic Ti₂Nb₁₀O₂₉, which has the lattice dimensions $a = 28.50$, $b = 3.805$, $c = 20.51$ Å, space group Amma, is solved by trial and error, and refined by electron-density projections. Its monoclinic dimorph, $a = 15.57$, $b = 3.814$, $c = 20.54$ Å; $\beta = 113^\circ 41'$ are shown, qualitatively, to have a closely related structure. Both have features which are common to TiNb₂O₇ and all three can be described as members of an homologous series Me_{3n}O_{8n-3}. Attempts to prepare additional homologues were not successful. (auth)

22766 ZIRCONIUM VERSUS STEEL AS REACTOR MATERIAL. A. A. de Boer (Euratom, Brussels). Atoom energie, 3: 69-76(May 1961). (In Dutch)

In the selection of reactor materials the stability of the material both against corrosion and erosion and against intensive neutron bombardment is of primary interest. The cross section for neutrons affects the resultant reactivity. Zirconium and steel were compared as reactor materials, particularly for a small reactor with high specific power. (tr-auth)

22767 UNDERSTANDING UO₂ FUEL ELEMENTS. J. A. L. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Atompraxis, 7: 121-6(Apr. 1961). (In English)

Canadian experience with UO₂ fuel shows that the knowledge gained from applied research has provided a basis for efficient element design. The extent of present knowledge is realistically summarised with specific mention of the unresolved problems. (auth)

22768 CONTRIBUTION TO THE STUDY OF THE PRECIPITATION OF RARE GASES IN METALS. Viviane Levy Alexis Kirianenko, Gilbert Brebec, and Yves Adda. Compt. rend., 252: 876-8(Feb. 6, 1961). (CEA 1922). (In French)

By means of an electronic Castaing probe microanalyzer local concentrations of rare gases were measured in metallic samples into which the gases were introduced by an electric discharge. After heating, the formation of gas bubbles in those regions where the gas concentration is sufficiently high can be shown by micrography. (auth)

22769 FISSION GASES IN NUCLEAR FUELS. R. Daras and J.-L. Berry (Centre d'Etudes Nucleaires, Saclay, France). Inds. atomiques, 5: No. 3-4, 83-93(1961). (In French)

After a brief review on the essential ideas on uranium fission, the behavior of rare gases in fuel materials is examined. The methods used for the study of the diffusion of fission gases, either by counting or by volume measurement and analysis, are indicated. The consequences of the formation of these gases in the case of uranium or its refractory compounds (UO₂ or UC) are discussed, the data being obtained from the numerous works recently published in this field. (tr-auth)

22770 CRYSTALLOGRAPHY OF THE Ru-B AND Os-B SYSTEMS. C. P. Kempter and R. J. Fries (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 34: 1994-5(June 1961).

The Ru-B and Os-B systems were investigated by x-ray powder diffraction. Two new hexagonal Ru-B phases were found: RuB₂(D_{6h}¹-P6/mmm, $a_0 = 2.852$ Å, $c_0 = 2.855$ Å) and Ru₂B₅(D_{6h}⁴-P6/mmc, $a_0 = 2.89$ Å, $c_0 = 12.81$ Å). In the Os-B system, two new hexagonal phases, isomorphous with the latter Ru-B phases, were found: OsB₂($a_0 = 2.876$ Å, $c_0 = 2.871$ Å) and Os₂B₅($a_0 = 2.91$ Å, $c_0 = 12.91$ Å). RuB₂ and OsB₂ are isomorphous with MoB₂; Ru₂B₅ and Os₂B₅ are isomorphous with W₂B₅. (auth)

22771 MADELUNG CONSTANTS FOR SEVERAL STRUCTURES. Quintin C. Johnson and David H. Templeton (Univ. of California, Berkeley). J. Chem. Phys., 34: 2004-7(June 1961). (UCRL-9439)

Madelung constants are given for 38 structures, some of which are relatively complex. The Madelung constants for binary compounds are compared with an empirical rule previously formulated. (auth)

22772 STUDY OF THE INITIAL PHASE IN THE OXIDATION OF NUCLEAR GRAPHITE BY AIR, AT TEMPERATURES BETWEEN 420°C AND 650°C. F. M. Lang, P. Magnier, S. May, and G. Pinte (Commissariat à l'Énergie

ie Atomique, Paris). *J. chim. phys.*, 58: 47-60(1961). (CEA-1891). (In French)

Certain nuclear graphites contain impurities, which are usually localized in well-defined regions. Qualitative and quantitative studies of the localizations were carried out by means of emission spectrography, autoradiography, activation, and x-ray radiography. Oxidation takes place particularly around these localizations, and when certain elements are present, such as V and Na, the rate increases to such an extent that it can lead to the formation of holes. The oxidation rates of various nuclear graphites investigated can vary by a factor of ten according to their origins; after volatilization of their impurities they show greater similarity. (auth)

22773 COMPOUND REPETITION IN OXIDE-OXIDE INTERACTIONS. THE SYSTEM $\text{Cs}_2\text{O}-\text{Nb}_2\text{O}_5$. Arnold Reisman and Joan Mineo (Watson Lab. International Business Machines, Yorktown Heights, N. Y.). *J. Phys. Chem.*, 65: 996-8(June 1961).

The mixed oxide system $\text{Cs}_2\text{O}-\text{Nb}_2\text{O}_5$ was investigated using differential thermal, x-ray, and density analyses. Five compounds were identified in the region 0 to 66 mole % Cs_2O . Except for a compound melting congruently at approximately 27.7 mole % Cs_2O ($5\text{Cs}_2\text{O} \cdot 13\text{Nb}_2\text{O}_5$) and 1415° , the remaining compounds, $2\text{Cs}_2\text{O} \cdot 15\text{Nb}_2\text{O}_5$, $\text{Cs}_2\text{O} \cdot 2\text{Nb}_2\text{O}_5$, $3\text{Cs}_2\text{O} \cdot 3\text{Nb}_2\text{O}_5$ and $\text{Cs}_2\text{O} \cdot \text{Nb}_2\text{O}_5$ melt incongruently at 1403° , 1513° , 972° , and 857° , respectively. The 2:15 and 5:13 compounds are isomorphic with the analogous rubidium compounds and the remainder are not. The trends observed in the lower members of the series were found to continue. The barely emerged compound $\text{Rb}_2\text{O} \cdot 4\text{Nb}_2\text{O}_5$ has no cesium analog, and the greatly submerged $4\text{Rb}_2\text{O} \cdot 3\text{Nb}_2\text{O}_5$ composition fails to repeat. (auth)

22774 STEPWISE ADSORPTION OF KRYPTON ON NICKEL. D. C. Fox and M. J. Katz (Army Signal Research and Development Lab., Fort Monmouth, N. J.). *J. Phys. Chem.*, 65: 1045-7(June 1961).

The adsorption at 200 to 600°C was found to generate stepwise isotherms on a model for a homogeneous surface with lateral adsorbate interactions. The sintering evidently proceeds at the expense of the high-energy surfaces, replaced in the transformed particle by surfaces which are more uniform geometrically and energetically. That a change in energy distribution of the crystallite surfaces themselves is more important in accounting for the transformation in the isotherms seems probable. This is evidenced by the fact that the greatest reduction in surface does not occur necessarily between 400 and 500° where the first steps are generated. (P.C.H.)

22775 EFFECTS OF THERMAL CYCLING ON THE MACRO AND MICROSTRUCTURE OF ALPHA-URANIUM. R. Salice (C.N.E.N., Milan) and F. N. Zein. *Met. ital.*, 53: 133-42(Apr. 1961). (In Italian)

Thermal cycling tests in the temperature ranges 550 to 100°C , 630 to 100°C , and 630 to 400°C were made on α -uranium to study the effects on macro and microstructure. The cycling usually causes subgrain formation, grain boundary corrugation, and migration accompanied by intergranular deformations. These changes develop faster for the 630 to 100°C cycle because the internal stresses are stronger. Samples with ragged grain boundaries are more easily crushed than those with smooth grain boundaries. The double texture formed during thermal cycling is discussed, and a correlation between the grain size and the double texture is suggested. (auth)

22776 THE EFFECT OF RARE-EARTH ELEMENTS ON CRYSTALLIZATION AND MECHANICAL PROPERTIES

OF CAST STEEL. B. B. Gulya'ev, I. A. Shapranov, O. N. Magnitskii, and Z. D. Nevzorova. *Redkozemel. Elementy v Stalyakh i Splavakh, Trudy Soveshchaniya*, 93-117(1959).

A study was made of the effect of rare-earth elements introduced to steel in the form of misch metal in amounts of 0.01 to 1.0% on S content, macrostructure, and mechanical properties. It was established that misch metal does not change the properties of non-alloyed Fe, but increases the plasticity and ductility of alloyed iron and steel.

22777 STUDY OF THE EFFECT OF RARE-EARTH ELEMENTS ON PHYSICO-MECHANICAL PROPERTIES OF CHROME-NICKEL-MOLYBDENUM STEEL. L. P. Kopp and G. K. Petukhov. *Redkozemel. Elementy v Stalyakh i Splavakh, Trudy Soveshchaniya*, 155-82(1959).

A study was made of the distribution of C, S, P, Ce, and O_2 , the macrostructure and the mechanical properties of Cr-Ni-Mo steel treated with Fe-Ce, added in an amount of 0.12 to 0.33% to the ladle or in the molds. The investigation was made with 850 -kg ingots from an electric furnace; blanks forged out of 2700 -kg ingots from a 10 -ton basic electric furnace, and 3550 -kg ingots from a 60 -ton basic open-hearth furnace. It was established that the addition of 0.15% Ce to the ladle ensured desulfurization of Cr-Ni-Mo steel by 50 to 60% . Steel treated with Fe-Ce behaves during forging like conventional Cr-Ni-Mo steel. In the central zone of the ingot the grouping and coarsening of S-compounds of rare-earth elements is observed; this causes a reduced ductility of the metal in this section. (OTS)

22778 THE EFFECT OF RARE-EARTH ELEMENTS ON THE STRUCTURE OF FRACTURE AND THE STRUCTURE AND PROPERTIES OF STEEL. M. A. Studnits, Yu. K. Konov, and A. I. Sokolikov. *Redkozemel. Elementy v Stalyakh i Splavakh, Trudy Soveshchaniya*, 183-95(1959).

Fractographic and autoradiographic methods were used to study the possibility of preventing intergranular fractures of 25KhNM steel by introducing rare-earth elements into the steel. Misch metal in amounts of 0.05 , 0.15 , 0.30 , 0.45 , and 0.60 was added to steel. It was found that the addition of 0.2 to 0.3% rare-earth elements to steel did not considerably affect the distribution of Mo, Cr, and P and reduced considerably the inter-dendritic segregation of C and S. Industrial tests on a 30 -ton open-hearth furnace showed that at a teeming temperature of 1550°C the addition of 0.3% misch metal to the steel prevents the formation of intergranular fractures of cast steel. (OTS)

22779 ON THE PROBLEM OF CAUSES OF REDUCED DUCTILITY OF X23H18 (Kh23N18) STEEL AT ELEVATED TEMPERATURES AND THE POSSIBILITY OF IMPROVING SAME BY RARE-EARTH ELEMENTS. L. P. Kopp, L. M. Shigidina, and O. D. Sudakova. *Redkozemel. Elementy v Stalyakh i Splavakh, Trudy Soveshchaniya*, 211-30(1959).

A study was made of the dependence between the macrostructure of a Kh23N18 steel ingot and the ductility of the steel at 900 to 200°C , and of the effect of rare-earth elements on the macrostructure of the ingot, the purity in respect to S and O_2 , and the ductility of the steel. Ductility was evaluated from the number of revolutions until the breakdown of a square section specimens of 10×10 mm, twisted at high temperatures. It is stated that introduction to steel of $\geq 0.2\%$ Ce caused a decrease of the S and O_2 content but did not change the N content. The positive effect of Ce on the ductility was established only at 1200°C and Ce content $\leq 0.1\%$. The effect of Ce is connected not as much with a reduced S content, as with deoxidation of the steel and the formation of compounds of rare-earth elements with S and O_2 having high melting points. (OTS)

22780 PHASE DIAGRAM AND THERMODYNAMIC PROPERTIES OF THE THORIUM-ZINC SYSTEM. P. Chl-

otti and K. J. Gill (Ames Lab., Ames, Iowa). *Trans. Met. Soc. AIME*, 221: 573-80 (June 1961). (IS-174)

Thermal, metallographic, and vapor pressure data were obtained to establish the phase diagram for the thorium-zinc system. Four compounds corresponding to the stoichiometric formulas Th_2Zn , ThZn_2 , ThZn_4 , and $\text{Th}_2\text{Zn}_{11}$ were observed. The melting points of these compounds under constrained vapor conditions were found to be 1055°, 1105°, 1095°, and 1015°C respectively. Four eutectics exist in this system with the following eutectic temperatures and thorium contents in wt. %: 1040°C, 89 Th; 945°C, 79 Th; 1045°C, 55 Th; and 995°C, 35 Th. The standard free energy, enthalpy, and entropy of formation for the compounds were determined from zinc vapor pressure data. (auth)

22781 ELECTRON STRUCTURE AND PROPERTIES OF HIGH-MELTING METAL NITRIDES. G. V. Samsonov (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Kiev). *Zhur. Strukt. Khim.*, 1: 447-52 (Nov.-Dec. 1960). (In Russian)

In general cases where transition metals with deficient d-levels combine with light metalloids such as boron, carbon, or nitrogen the binding electron concentration and distribution are determined by the number and energy of electrons at the d-level of the metal atom and by the initial ionization potentials of the metalloid atom. The electron condition, the electric conductivity (at high and low temperatures) of homogeneous phases, the heat of formation, the diffusion activation energy, and magnetic susceptibility were analyzed as a special and extreme case in transition metal nitrides. The nitrides simultaneously exhibit properties of metallic and ionic compounds: Ti, Zr, Hf, and V nitrides are prevalently metallic; Mo and W nitrides are ionic; and Nb, Ta, and Cr exhibit both, with the latter prevailing. (tr-auth)

22782 LUBRICANTS, GREASES AND HYDRAULIC FLUIDS. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). May 1961. 21p. (SB-459)

A large bibliography is presented on reports dealing with lubricants, greases, and hydraulic fluids. The reports are listed in U.S. Government Research Reports and Technical Translations. (D.L.C.)

22783 MAGNESIUM. OTS Selective Bibliography. (Office of Technical Services, Washington, D. C.). Nov. 1960. 23p. (SB-445).

A large bibliography is presented on magnesium metals, alloys, and compounds and includes reports listed in U. S. Government Research Reports and Technical Translations. (D.L.C.)

Radiation Effects

22784 (AD-249085) NUCLEAR RADIATION RESISTANT POWER TRANSISTORS. Final Report, May 15, 1959 to July 14, 1960. A. Byer (Philco Corp. Lansdale Div., Penna.). Contract DA-36-039-SC-78307. 112p.

A development program for radiation-resistant power transistors is described. The program comprised a phase in which transistors were designed and built to meet Signal Corps pre-exposure specifications, and a phase in which the transistors were irradiated. The problems encountered in each phase are discussed. Extra experiments such as a study of $\langle 111 \rangle$ oriented Ge, shock tests and various irradiation tests were conducted. Conclusions and recommendations are included. (J.R.D.)

22785 (AD-251761) NGL PLATFORM NUCLEAR RADIATION PROGRAM. Bimonthly Progress Report No. 4, November 23, 1960 to January 23, 1961. (Litton Systems,

Inc., Beverly Hills, Calif.). Jan. 1961. Contract AF33(600)-41452. 151p. (BH-59-3461.26)

The results are presented of tests of high-frequency transistors and diodes in a nuclear environment. The test results are compared with those previously reported. The results of nuclear environment tests on certain printed circuit boards are given. The base-line data of the d-c amplifier are presented together with schematics delineating the recommended modifications for increasing its nuclear resistance. (B.O.G.)

22786 (AE-53) NEUTRON DAMAGE IN STEELS CONTAINING SMALL AMOUNTS OF BORON. H. P. Myers (Aktiebolaget Atomenergi, Stockholm). May 1961. 23p.

Certain low alloy steels contain small amounts (0.003 to 0.007 wt. %) of boron which contributes to the development of the air hardening properties of these steels. Such steels appear attractive for reactor pressure vessel construction but the question of whether they will, due to the (n, α) reaction in boron, be more susceptible to neutron radiation damage than other steels which do not contain boron has to be studied. An attempt was made to estimate the importance of damage arising through boron fission relative to that caused by fast neutrons by assuming that the two sources of damage will be proportional to the numbers of displaced atoms produced in the two processes when no annealing or recombination of defects occurs. Within the approximations used it was concluded that in a neutron spectrum which may be represented by an equivalent thermal flux ϕ_t and an equivalent fast flux at 1 Mev of ϕ_f then D , the ratio of damage to boron fission to that caused by fast neutrons, is $D = 4.5 \times 10^{-2} \cdot \phi_t / \phi_f$ (for 0.003 wt. % B). For the conditions at the inside of the reactor tank to R3 this would imply $D = 1.2 \times 10^{-2}$, i.e., if the R3 tank were built with a steel containing 0.003 wt. % B then damage due to boron fission would be only ~1% of that caused by fast neutrons. Further problems with such steels including the probability of embrittlement due to the introduction of boron fission fragments lithium and helium and the possibility of a radiation enhanced diffusion of boron which might lead to accentuated slow strain rate embrittlement are discussed. It was concluded that a constructional steel containing ~0.003 to 0.007 wt. % B should not on this account be more susceptible to radiation damage than other non-boron containing steels. (auth)

22787 (CRRM-1010) THE EFFECT OF FAST-NEUTRON IRRADIATION ON THE DENSITY, X-RAY LATTICE PARAMETER AND LINE BREADTH OF METALS G. R. Piercy and R. H. Tuxworth (Atomic Energy of Canada Ltd., Chalk River, Ont.). Mar. 1961. 40p. (AECL-1251)

The effect of fast-neutron irradiation at 50°C on the density, x-ray lattice parameter, and line breadth of Al, Cu, Pd, Au, Pt, Fe, Mo, W, and Zr was investigated using an integrated fast flux of 1.4×10^{20} n/cm². None of the irradiated metals possessed a sufficiently simple defect structure to allow the calculation of the defect density. However, for zirconium, platinum, and copper, the measurements did indicate the type of defect present after neutron irradiation. (auth)

22788 (GA-2268) IRRADIATION OF BeO-UO_2 CERAMICS. D. E. Johnson (General Atomic Div., General Dynamics Corp., San Diego, Calif.), J. Koretzky and A. K. Smalley (Battelle Memorial Inst., Columbus, Ohio). [1961?]. Contracts W-7405-eng-92 and AT(04-3)-187. 18p.

For presentation at the ASTM Meeting at Atlantic City, New Jersey, June 28, 1961.

Fuel pellets composed of 19 and 28 vol. % UO_2 dispersed

a BeO matrix were irradiated to exposures of 2×10^{20} and 7×10^{19} fissions/cm², respectively. The specimen surface temperatures were approximately 1500°F. The UO₂ is present in the form of irregularly shaped grains ~125 μ average diameter. No significant change in the dimensions of the pellets or in the lattice parameters of the BeO matrix was observed. The crushing strength of the pellets and their resistance to abrasion were reduced as a result of the irradiation. (auth)

2789 (IBM-61-521-3) STUDY OF EFFECT OF HIGH-INTENSITY PULSED NUCLEAR RADIATION ON ELECTRONIC PARTS AND MATERIALS (SCORRE). Report 6, 3. Third Quarterly Progress Report, January 1, 1961–March 31, 1961. (International Business Machines Corp. SD Space Guidance Center, Owego, N. Y.). Contract A 36-039 SC 85395. 20p.

A description is given of the core radiation tests to be conducted at the Sandia Pulsed Reactor Facility (SPRF). The pulse response of ferrite and tape wound cores used for memory and logic applications will be observed during irradiation. The Sandia Pulsed Reactor (SPR) will be used as the radiation source. (auth)

2790 (JAERI-1014) RADIATION EFFECTS IN LiF CRYSTAL. Report 14. Kazuko Kubo, Haruhiko Motohashi, and Yoshio Katano (Japan Atomic Energy Research Inst., Tokyo). 1960. 14p.

The lattice parameters and the optical absorptions of LiF single crystals which were irradiated with neutrons of $\times 10^{17}$ nvt and isothermally annealed at successively higher temperatures up to 800°C were measured at room temperature. The microscopic observations were also carried out. The steps in the recovery curve of lattice parameter vs. annealing temperature remarkably correspond to the increase and decrease of the M-band and F-band (colloidal) and the last step corresponds to the formation of the cavities in the crystal which appear to have a close connection with the dislocation network in the crystal. (auth)

2791 (NAA-SR-Memo-6108) THORIUM, A BIBLIOGRAPHY. M. Bloomfield (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 7, 1961. 10p.

A bibliography is presented accumulating data which deal with radiation effects on thorium metal. There are, however, some references to the physical properties of thorium as well as radiation effects, and a few references to production, preparation, determination, and reprocessing methods. (109 references.) (auth)

2792 (NAA-SR-Memo-6228) RADIATION EFFECTS ON DISPERSION FUEL ELEMENTS; A SELECTED BIBLIOGRAPHY. M. Bloomfield (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 23, 1961. 15p.

One hundred and eighty six references containing data on the radiation effects on dispersion fuel elements are listed. Some of the references include physical properties and preparation and reprocessing methods. The bibliography is divided into the following sections: general; aluminum–uranium; aluminum–uranium dioxide; magnesium–uranium; plastic fuels, tape fuels, etc.; stainless steel–uranium oxide; zirconium–uranium; zirconium hydride–uranium; and dispersion based on uranium oxides in matrices other than aluminum and stainless steel. (auth)

2793 (NARF-61-5T) THE EFFECTS OF REACTOR RADIATION ON THE ELECTRICAL PROPERTIES OF ELECTRONIC COMPONENTS. PART VII. RESISTORS

AND VACUUM TUBES. E. E. Palmer and D. Howell (Convair, Fort Worth, Tex.). June 7, 1961. Contract AF33(600)-38946. 74p. (MR-N-268)

Several types of vacuum tubes and resistors were irradiated with the Ground Test Reactor for a period of 100 hours at a power level of 1 megawatt. Data were taken on the components before, during, and after the irradiation. The vacuum tubes received a maximum radiation exposure of 8.64×10^{15} n_t/cm² and 3.9×10^{10} ergs/gm(C). A small increase in the average plate current was noted for all tube types. Pentodes subjected to the high-flux field exhibited the largest percent change ($\approx 6\%$) while diodes remained relatively unaffected at these radiation levels. The resistors received a maximum radiation exposure of 1.4×10^{16} n_t/cm² and 6.2×10^{10} ergs/gm(C). The degree of damage was dependent upon the material and type of construction of the individual resistor types. The maximum observed change ($\approx 6\%$) occurred in fixed-composition resistors. (auth)

22794 (TID-12881) A STUDY OF DRIFT MOBILITY IN NEUTRON IRRADIATED n-TYPE GERMANIUM. William H. Closser (Sandia Corp., Albuquerque, N. Mex.). 1961. 58p. (SCDC-2313)

A description is given of the results of a drift-mobility experiment on n-type germanium which was bombarded with high-energy particles, and a model is postulated which tentatively explains the results for the case of neutron bombardment. The results show that the drift mobility increases for low values of neutron flux, and then decreases very rapidly, approaching zero as the sample is driven intrinsic by the radiation. The observed mobility increase was large enough to be removed from the realm of experimental error, and was found to be repeatable. The results of the drift-mobility experiment on electron-irradiated material show that the mobility decreases with increased irradiation, and that the decrease is similar to that observed for neutron irradiations. The electrons are known to introduce point defects, which led to the development of the proposed model. A mathematical analysis showed that the mobility increase in neutron-irradiated material cannot be explained in terms of theoretical models which picture the neutron damage site as a charged scattering center, or as a group of such centers. Further mathematical analyses show that a variable mobility, which can be postulated for neutron damage, cannot explain the results either. From other experimental work it was known that Frenkel-type defects did exist in neutron-irradiated germanium, and with some evidence supporting the Gossick model. A model was proposed to explain the experimental results, which combines the Gossick-void model and the point-defect model, and says that the neutron damage site is not one or the other, but instead looks like a combination of both as far as the electrical properties of the material are concerned. The void fraction caused by the neutrons is calculated using flux measurements. The number of point defect-associated scattering centers introduced per incident neutron, as calculated from the model using the necessary refinements, is found to be seven for the case of the Omega West irradiations. Although the model is very crude and qualitative, it is believed to have some merit as an interim means of explaining neutron damage in n-type germanium. (auth)

22795 (VDIT-16.2) RADIATION EFFECTS ON SOLID URANIUM-BASED NUCLEAR FUEL MATERIALS. SUPPLEMENT I. A Bibliography. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). May 1961. 45p.

One hundred and fifty four abstracts are presented in this supplement to the bibliography on radiation effects in solid

uranium-based nuclear fuel materials. Publications which became accessible up to April 1961 are included. The listing is divided under the following headings: general, metallic uranium, binary alloys, ternary alloys, other alloys, oxides (ceramics), carbides, and dispersion fuel. A uniterm-index containing 18 terms is included. (M.C.G.)

22796 HIGH ALLOY STEELS IN NUCLEAR ENERGY PLANTS. [PART] II. J. Jägersberger. *Atomwirtschaft*, 6: 283-8 (May 1961). (In German)

The effects of radiation on the properties of high-alloy steels and corrosion problems arising from irradiation are major factors in the construction and economy of nuclear energy plants. A theoretical computation of the change in technological characteristics is still not possible in spite of numerous investigations. (auth)

22797 THE EFFECT OF INTERNAL STRESSES DUE TO IRRADIATION GROWTH AND THERMAL CYCLING ON THE CREEP OF URANIUM, IN THE CASES OF BOTH ELASTIC AND PLASTIC BEHAVIOUR. W. S. Blackburn (C. A. Parsons and Co., Ltd., Fossway, Newcastle-upon-Tyne, Eng.). *Reactor Sci. and Technol., J. Nuclear Energy*, Pts. A and B, 14: 107-16 (May 1961).

Theories are developed to derive differential equations from which the effect of irradiation growth and uniform continuous thermal cycling on the creep of uranium under applied uniaxial stress may be determined when the material remains elastic. Two alternative assumptions are made of uniform deformation and of uniform internal stress in the uranium crystals. Solutions are obtained in several cases and an approximate method is presented which applies over a large range if primary creep effects are neglected. Over this range, tables are deduced from which it may be seen how the internal stress at any temperature increases with the irradiation growth and the mean temperature deviation of the cycle, while remaining independent of its period. The way is shown in which the logarithm of the creep acceleration factor varies as the logarithm of the ratio of internal to applied stress decreases, decreasing initially linearly and subsequently more slowly. The creep rate under a uniaxial load has also been deduced when the material has become plastic due to irradiation growth or to a constant rate of change of temperature and, also, if the applied stress is small, when it is plastic due to thermal cycling and irradiation growth acting simultaneously. Satisfactory agreement with experiment is found for the results in both the elastic and plastic ranges. (auth)

22798 THE LANTHANUM-BORON SYSTEM. Robert W. Johnson and A. H. Daane (Ames Lab., Ames, Iowa). *J. Phys. Chem.*, 65: 909-15 (June 1961).

From thermal, metallographic, x-ray, and electrical resistance data a phase diagram is proposed for the lanthanum-boron system. Two compounds are formed, LaB_4 and LaB_6 . The former has a very narrow range of homogeneity and decomposes peritectically at $1800 \pm 15^\circ$. The crystal system is tetragonal, and the compound is a metallic type conductor. LaB_6 exists in the range 85.8 to 88% boron, melts above 2500° , and has a simple cubic lattice. The color of this compound changes with composition, going from purple to a bright blue with increasing boron content. The addition of boron to lanthanum has no measurable effect on the melting point or transition points of the metal. The addition of lanthanum to boron appears to have very little effect on the melting point of boron. There is metallographic evidence for an allotropic transformation in boron above 2100° . Evidence also is given for a new compound CaB_4 , which appears to be isomorphous with LaB_4 . (auth)

22799 EFFECTS OF IRRADIATION AND ROLLING ON THE TENSILE BEHAVIOR OF POLYETHYLENE. Yoshinori Tsunekawa, Moriya Oyane, and Kohei Kojima (Osaka Univ.). *J. Polymer Sci.*, 50: 35-44 (Mar. 1961).

Tensile properties of low-pressure polyethylene subjected to both irradiation and rolling were studied. Co^{60} was used as the γ source. The anisotropic properties induced by rolling and irradiation were measured by testing the tensile behavior of specimens cut at 0° , 45° , and 90° to the direction of rolling. The yield strengths of specimens cut parallel to the direction of rolling increased with increasing reduction in thickness, but the yield strengths of those cut at 45° and 90° were scarcely affected. The yield strengths of specimens that were irradiated, or irradiated and rolled, increased with increasing irradiation doses, reaching maxima at definite irradiation doses, and then decreased with increasing irradiation, regardless of whether the specimens were irradiated after rolling or rolled after irradiation. The final elongations of the specimens that were irradiated after rolling and cut parallel to the direction of rolling decreased slowly with increasing irradiation, but those of the specimens cut at right angles to the direction of rolling decreased very rapidly. In contrast, the final elongations of all specimens that were rolled after irradiation decreased very slowly regardless of the cutting direction. It may be concluded from the experimental results that the tensile properties of polyethylene irradiated after rolling are more anisotropic than those of the polyethylene rolled after irradiation. (auth)

22800 MECHANICAL AND RADIATION INDUCED FAULTING IN SODIUM AZIDE. D. T. Keating (Brookhaven National Lab., Upton, N. Y.) and S. Krasner. *Phys. and Chem. Solids*, 20: 150-61 (June 1961). (In English). (BNL-5249)

Sodium azide powders subjected to mechanical grinding, gamma irradiation, and pile irradiation were examined by x-ray diffraction techniques. Faulting and strain are found in the ground samples with no indication of decomposition. Faulting and strain are also found in samples subjected to irradiation accompanied by signs of decomposition such as coloration, lowering of the ignition temperature, and a lattice contraction in the direction of the long dimension of the azide ion. Annealing removes some of the faults and strain both in the ground and irradiated samples, but in the latter cases a significant fraction of these imperfections are stable even at the ignition temperature. The two types of irradiation produce qualitatively similar results, and quantitative differences are ascribed to the more inhomogeneous decomposition induced by pile irradiation. In both cases a return to stoichiometry upon annealing is evidenced by a disappearance of the lattice contraction. (auth)

22801 THE METHOD OF CORROSION AND ELECTROCHEMICAL INVESTIGATIONS OF METALS IN A LIQUID STREAM UNDER THE ACTION OF IONIZING RADIATION. A. V. Byalobzheskii and V. D. Val'kov. *Trudy Inst. Fiz. Khim., Akad. Nauk S.S.S.R.*, No. 7, 119-32 (1959).

The method and the apparatus are described for corrosion and electric-chemical investigations of metals in an electrolyte stream under the effect of an ionizing radiation. The methods are presented for determining the overcurrent speed, the electron absorption, the energy of emission, and the temperature of the solution in the irradiation zone. The action mechanism is stated for electron radiation of $2-10^{20}$ ev/cm² sec intensity upon the corrosion of Al in a 3% NaCl solution. The heating of the electrolyte and the metal due to their absorption of radiation energy

furthers the breaking up of the forming film. The interaction of the noted factors leads to the localization of the corrosion pits of Al. The investigation of the radiation effect on the corrosion behavior of the pairs Zr-Al, and Ti-Al in a 30% HNO_3 solution showed that the electron radi-

ation considerably increases the corrosion current of the pairs mentioned. For the Zr-Al pair, the increase of the corrosion current to a considerable extent is caused by the durable changes developing in the irradiated system and exerting their action also after stopped irradiation. (OTS)

PHYSICS

General and Miscellaneous

22802 (AERE-C/R-2627) COMPARISON OF Co^{60} AND OTHER γ ACTIVE SOURCES USING A TPA MK. II IONIZATION CHAMBER. K. L. Aitken and F. W. Cornish (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1958. 15p.

The use of an ionization chamber, containing a detecting medium of 20 atmospheres of argon, for the precise comparison of activities greater than $5 \mu\text{Ci}$ is described. Measurements of the response to γ rays of different energies are compared with calculated values. (auth)

22803 (AERE-M-877) DENSITY AND SURFACE TENSION MEASUREMENTS ON AQUEOUS SOLUTIONS OF WATER-SOLUBLE NIGROSINE USED IN FILM THICKNESS MEASUREMENTS. J. A. Crozier, C. F. Hewitt, and P. C. Lovegrove (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). May 1961. 6p.

The surface tension and density of solutions of nigrosine were found to be only slightly different from water, at concentrations up to 2.1% by weight. The dye therefore appeared safe to use in two-phase flow film thickness measurements by a light absorption technique. (auth)

22804 (ANL-6326) PHYSICS DIVISION SUMMARY REPORT. (Argonne National Lab., Ill.). Mar. 1961. Contract W-31-109-eng-38. 97p.

Half lives were determined for 10 transitions in low-lying energy levels, excited by slow neutron capture, in Mn^{56} , Rh^{104} , Cu^{64} , Al^{28} , and I^{128} . Internal magnetic fields at the nuclei of Fe^{57} and Sn^{119} in various magnetic media were studied with the Mössbauer effect, and their nuclear Zeeman effects were analyzed. Energy spectra, angular distributions, and reduced widths were obtained for (d,t) reactions on Fe^{54} , Fe^{58} , Ni^{58} , Ni^{60} , and Ni^{61} , and the data used to provide information on the ground-state wave functions of these isotopes. The β and γ radiations associated with Er^{172} decay were measured and a decay scheme proposed for Er^{172} . The level structure of F^{20} at 1 to 150 keV above the neutron binding energy was studied by the $\text{F}^{19}(\text{n,n})\text{F}^{19}$ process. The region around 100 keV was found to contain a cluster of levels. A polystyrene film was prepared with a thickness of 530 Å and its vacuum ultraviolet spectrum determined in the range 1100 to 2300 Å. Experimental data on the kinetic energies of fragments from electron bombardment of ethylene and acetylene are interpreted in terms of a "temperature." The form factors for the inelastic scattering of high-energy electrons are calculated for Sm^{152} with the collective model of a deformed nucleus. A single-particle rotational model, which includes band mixing, was found to give a qualitative fit to many of the properties of the low-lying states in Fe^{57} with the exception of those depending on the intrinsic wave function of the $1/2^-$ ground state. (D.L.C.)

22805 (ARF-1176-1) WAVE PROPAGATION UNDER ANOMALOUS CONDITIONS. Quarterly Report No. 1. C. M. Haaland (Illinois Inst. of Tech., Chicago. Armour Research Foundation). May 15, 1961. Contract DA36-039 SC-87199. 60p.

Charge-exchange reactions involving negative ions and neutral particles are postulated to account for the possible existence of NO_2^- in the atmosphere, and for its persistent

appearance in laboratory gas discharges. NO_2 is not present in adequate densities in either of these environments to account for the NO_2^- density. A complete set of general rate equations were written for the ionized chemosphere (30 to 200 km), including all probable molecular and ionic combinations of oxygen and nitrogen atoms and including all known and postulated reactions between them. Using available data for the atmospheric densities of N_2 , O_2 , O , and O_3 , the set of equations for negative particles was investigated to determine the most important processes at 65 km and at 110 km. At 65 km the most important loss process for electrons is attachment to O_2 forming O_2^- , while at 110 km, dissociative recombination with positive ions is the most important loss process. For the negative ions O^- , O_2^- , and O_3^- , charge transfer processes with neutral particles are the predominant loss mechanisms, for exceeding photodetachment and charge neutralization with positive ions. Charge neutralization with positive ions is important as a loss process for the principal negative ion, which may be NO_2^- . The equilibrium density for electrons under a constant ionization rate of s_e electron-ion pairs per cm^3 per second is given by $(n_e)_{\text{eq}} = 10^{4.1} s_e^{1/2}$ under most conditions. An experiment is described for measuring some negative ion charge-exchange reactions at thermal equilibrium. The method employs an electromagnetically operated fast mechanical shutter in conjunction with a Bendix time-of-flight mass spectrometer. The equations of motion for the shutter were solved under certain simplifying assumptions. (auth)

22806 (BM-RI-5711) HEATS AND FREE ENERGIES OF FORMATION OF FERRITES AND ALUMINATES OF CALCIUM, MAGNESIUM, SODIUM, AND LITHIUM. M. F. Koehler, R. Barany, and K. K. Kelley (Bureau of Mines, Berkeley, Calif.). Feb. 1960. 17p.

The results of new experimental work for obtaining the heats of formation of five ferrites ($\text{Ca}_2\text{Fe}_2\text{O}_5$, CaFe_2O_4 , MgFe_2O_4 , NaFeO_2 , and LiFeO_2) and one aluminate (CaAl_2O_4), and a review and revision of previous similar work on five aluminates ($\text{Ca}_3\text{Al}_2\text{O}_6$, $12/7 \text{ CaO} \cdot \text{Al}_2\text{O}_3$, CaAl_2O_4 , NaAlO_2 , and LiAlO_2) are presented. The results for the 11 compounds are combined with entropy and high-temperature heat content data to derive tables of heats and free energies of formation (both from the oxides and from the elements) for the temperature range 298 to 1,800°K. The relative stabilities of the compounds are discussed. (auth)

22807 (GA-1403) MICROWAVE MEASUREMENTS OF ELECTRON ATTACHMENT RATES. V. A. J. van Lint and E. G. Wikner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 9, 1960. Contract AF29 (601)-2779. 11p.

Presented at the Symposium of the Professional Group on Microwave Theory and Techniques, Institute of Radio Engineers, held at San Diego, California, May 9-11, 1960.

The microwave-afterglow technique is useful in measuring the thermal-electron attachment or recombination processes in ionized gases. Additional measurements were made on oxygen-nitrogen and oxygen-helium mixtures, various nitrogen oxides, and water vapor. Temperature studies were made of electron attachment in oxygen and oxygen-nitrogen mixtures. It is planned that these measurements be extended to lower pressures and to a more complete study of electron-ion recombination. (auth)

22808 (JEN-84-DF/I-26) ANALOGUE NETWORK FOR THE STUDY OF ELECTRIC AND MAGNETIC FIELDS WITH

CYLINDRICAL SYMMETRY. C. Sanchez Del Rio, S. Santiago, and F. Verdager (Spain. Junta de Energia Nuclear, Madrid). 1960. 10p.

A resistor network is described which can be used to solve the partial differential equations for the scalar potential and for the only component of the vector potential in problems with cylindrical symmetry. To calculate the values of the resistors a general method is presented valid for any equation which can be solved by the resistor network analogy. (auth)

2809 (NAA-SR-Memo-6155) **RAPID SURFACE AREA MEASUREMENTS OF URANIUM OXIDE POWDERS BY A MODIFIED "INNES" METHOD.** Tennyson Smith (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 17, 1961. 18p.

An apparatus was designed and operated to measure the surface area of powders by a dynamic method in about fifteen to twenty minutes. The apparatus is very simple to build and operate and is rugged (all metal except for a quartz sample holder). The surface area of anatase and titanium dioxide powders were measured to $\pm 5\%$. (auth)

2810 (NASA-TN-D-863) **A TECHNIQUE FOR CRYOPUMPING HYDROGEN.** Jack Grobman (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). June 1961. 28p.

Experimental tests performed in vacuo indicated that a chemical adsorption reaction can be used to facilitate the cryopumping of hydrogen with liquid-nitrogen-cooled condensers. Cryopumping is accomplished by reacting hydrogen with oxygen to form water, which will readily condense on a liquid-nitrogen-cooled surface. The reaction in vacuo was performed on a solid catalyst, which consisted of a bed of palladium-coated alumina pellets. Cryopumping was observed at pressures as low as about 0.4 micron of mercury. A laboratory cryopump consisting of 5.8 pounds of catalyst and a liquid-nitrogen-cooled condenser achieved a pumping speed of about 570 liters per second at 1.0 micron of mercury. A laboratory model of a cryopump which could be used in an electric rocket test facility was studied. The experimental data thus obtained were used to estimate the size of the catalyst bed necessary to test a 50-kilowatt electric thermal rocket with a hydrogen propellant flow rate of 5.3×10^{-4} kilogram per second (a pumping speed of 580,000 liters/sec at an operating pressure of 10 microns of mercury). (auth)

2811 (NP-10002) [SEMICONDUCTING AND FLUORESCENT PROPERTIES OF URANIUM COMPOUNDS]. Technical Data Number 2. I. H. Warren (British Columbia Univ., Vancouver). Feb. 1961. Includes Appendix: ON THE USES OF URANIUM IN PHOSPHORS. I. H. Warren. Jan. 1961. 8p.

Issued by: Canadian Uranium Research Foundation.

A bibliography of ten references on the properties of uranium oxides is presented. A table of fluorescing compounds and their luminescence colors is presented with 49 associated references. An appendix on the uses of uranium in phosphors is included. (D.L.C.)

2812 (NP-10225) **THE SPECIFIC HEAT OF FERRITES AT LIQUID HELIUM TEMPERATURES.** Technical Report No. 5. K. R. Atkins and S. R. Pollack (Pennsylvania Univ., Philadelphia). [1960]. Contract Nonr-551(28). 156p.

An investigation was made of the spin-wave theory prediction that for a ferromagnetic or ferrimagnetic material there should be a contribution to the specific heat which is proportional to the temperature to the $3/2$ power. Previous

measurements by Kouvel of the specific heat of the ferrite Fe_3O_4 indicated the presence of this term. This work was extended to include nickel, lithium, magnesium, and cobalt ferrites. The temperature dependence of the specific heat of these ferrites was measured at liquid helium temperatures and in all cases the spin wave contribution was identified. The exchange integral was computed and the Curie temperature calculated. The Debye characteristic temperatures for these ferrites were also evaluated from these data by separating the lattice contribution from the spin wave contribution to the specific heat. A detailed description of the experimental techniques, the equipment, and the samples is included. (M.C.G.)

2813 (NP-10230) **A REPORT ON SOLUTIONS TO THE TWO DIMENSIONAL SPIN WAVE HAMILTONIAN.** Technical Report No. 1. David I. Paul (California Univ., Los Angeles). May 1961. Contract Nonr 233(63). 15p.

Exact solutions are obtained for the Dirac spin wave Hamiltonian of a two dimensional periodic rectangular array of N atoms. Each atom in its isolated state is considered to have one outer electron which is in an s state, all other electrons being in closed shells. It is shown that if the number of spin waves is not greater than the number of atoms in either of the two lattice directions, exact solutions exist in which the spin waves are independent of one another except to the extent that they obey the Pauli exclusion principle. Thus, the energy eigenvalues for these particular solutions are rigorously additive and are the same as those obtained by Bloch although the number of allowed eigenstates are more restricted. (auth)

2814 (NP-10235) **PROGRESS REPORT NO. 19, SEPTEMBER 15, 1960 - MARCH 31, 1961 TO THE JOINT SERVICES TECHNICAL ADVISORY COMMITTEE.** Report R-452.19-61. Ernst Weber (Brooklyn. Polytechnic Inst. Microwave Research Inst.). Contract AF18(600)-1505. 164p.

Electromagnetics. A mathematical treatment of modes guided by a moving periodic plane boundary is presented. Wood's diffraction anomalies are considered. The case of diffraction by a cylinder having a variable surface impedance is treated. A network approach to the analysis of Cherenkov radiation problems is presented. **Plasma Electrophysics and Electronics.** Extensive studies were made of surface and acoustic waves in plasma. Transmission power of a microwave beam through a H_2 discharge plasma was measured and used to derive a value for the collision frequency. The motion of a charged particle in an axially symmetrical magnetostatic field is analyzed. Studies of the Jungle Gym periodic structure and traveling wave tube attenuator are presented. The properties of an electrodeless hydrogen plasma were measured. **Solid State and Materials Research.** The results of an investigation of the spin resonance of V^{3+} in liquid SO_2 indicate that a "near order" must exist in the immediate vicinity of the ion. Observations on breakdown in Cu- and Sb-doped germanium are reported. The dominant lattice sum A_{00}^0 was calculated for cubic crystals with the Poisson transform. Work performed in the construction of a novel microwave oscillator is described. Studies of the magnetic properties of ferrite films are reported. **Microwave Circuits.** The case of a ferrite ellipsoid in a single-mode rectangular waveguide is analyzed. Representation of microwave cavities by networks is considered. **Network Theory.** The following subjects are discussed and/or analyzed: nullators and norators, scattering matrices normalized to complex port numbers, Darlington synthesis, transmission line two-ports, two-variable reactance functions, stability of tunnel diodes, and semiconductor

Hall plate circuits. Systems and Control. The following items are discussed: flow graph topology, model-reference adaptive systems, biological network analogs, and binary communication systems. (D.L.C.)

22815 (NP-10259) A STUDY ON THE EFFECT OF A PROGRESSING SURFACE PRESSURE ON A VISCOELASTIC HALF-SPACE. (Weidinger (Paul), New York). Feb. 20, 1961. For MITRE Corp. Contract AF33(600)-39852. 62p. (SR-22).

Theoretical studies were carried out on the stress wave propagation in a visco-elastic half-space geological model. Stresses produced by progressing surface pressures were considered in particular, and a plane strain solution for the stress distribution is presented. (D.L.C.)

22816 (NP-10280) MICROWAVE CAVITY MEASUREMENTS OF IONIZATION IN THE TRAIL OF HIGH VELOCITY PELLETS. Interim Technical Report No. 13, D. K. Gehmlich, R. W. Grow, and D. R. Harrison (Utah. Univ., Salt Lake City). Oct. 31, 1959. Contract DA-04-495-ORD-451. 54p.

The ionization density of the ion trail following a high speed cylindrical aluminum pellet was measured in a resonant microwave cavity. The change in the resonant frequency of the cavity was observed when the ion trail was within the cavity. Ion densities between 10^{13} and 10^{14} ions/cm³ were measured for pellet velocities between 1.7 and 2.1 km/sec at a distance of 30 cm from the end of the gun barrel. Ion densities between 1 and 3×10^{13} ions/cm³ were measured for velocities between 1.9 and 2.1 km/sec at 73 cm down range. The diameter of the ion stream was found to be about 2 inches. Within the range of velocities cited, the flare length was approximately proportional to pellet velocity. A measurement of the delay time between the pellet and the onset of ionization at 30 and 73 cm down range indicated that the ionization stream decelerates faster than the pellet. (auth)

22817 (NP-10281) MAGNETIC SUSCEPTIBILITIES OF CRYSTALLINE STABLE FREE RADICALS IN THE 77-293°K TEMPERATURE RANGE. Technical Report No. 1, October 1, 1959-May 1, 1961. William Duffy, Jr. (Santa Clara, Calif. Univ.). June 1, 1961. Contract Nonr 2985(01). 18p.

The powder susceptibilities of crystalline stable free radical samples of Wurster's blue, DPPH and 1,3-bisdi-phenylene-2-phenylallyl were measured as a function of temperature from 77 to 293°K. All exhibit negative Curie points with values at -36 to -6°K. For Wurster's blue, the Néel temperature is found to be 186°K. The microbalance system constructed for the measurements is described. (auth)

22818 (NP-10314) NEUTRON SOURCES AND THEIR CHARACTERISTICS. Technical Bulletin NS-1. (Atomic Energy of Canada Ltd. Commercial Products Div., Ottawa). [nd.]. 24p.

The various modes of neutron production are discussed, and the characteristics and construction of alpha-neutron and photoneutron sources are given. Gammas from alpha-neutron sources are considered. Some possible applications of small, portable neutron sources are discussed briefly. Radiation protection and shipping precautions are considered. (D.L.C.)

22819 (NYO-9579) APPLICATIONS OF ULTRASONIC ENERGY; ULTRASONIC COALESCENCE IN GASEOUS SYSTEMS. William B. Tarpley and C. D. McKinney (Aero-projects, Inc., West Chester, Penna.). Apr. 1961. Contract AT(30-1)-1836. 90p.

Radioactive particles less than 1- μ diameter are expected

to remain in the off-gas from the fluidized-bed calciner at Idaho Falls, after the larger particles are removed by conventional gas-cleaning equipment. The concentration of these particles must be reduced from several hundred to a few micrograms per cubic foot in order to limit the radioactivity of the stack discharge to a safe level. Ultrasonic coalescence of simulant solid aerosols in this particle size range, using an additive fog aerosol of collectible size, was worked out and proven capable of reducing concentrations to as low as 0.002 $\mu\text{g}/\text{ft}^3$. To accomplish this, a method was developed for producing a high-intensity ultrasonic standing-wave field through the use of air- or steam-driven acoustic generators. No other proposed process was demonstrated to work in such a low range, nor to have the desired fail-safe features, and ready maintenance necessary for radioactive dust collection. A field trial with an apparatus based on the prototype is recommended. The apparatus design can be scaled up to full process capacity. (auth)

22820 (SCL-T-334) INTERNAL FIELD EMISSION FROM AN INTERFERENCE OR DISTURBANCE CENTER, SECTION 31. Walter Franz. Translated by Marcel I. Weinreich (Sandia Corp.) of excerpt from Chapter II of *Handbuch der Physik, Dielektrika*, 17: 155-255(1956). 6p.

Internal field emission from an interference or disturbance center is computed. The computation rendered by means of a potential cup is suitable for neutral disturbance centers, i.e., for such disturbance centers which do not possess any electrical charge after removal of the electron. (W.D.M.)

22821 (TID-13047) FUNDAMENTAL RESEARCH IN PHOTOEMISSION. Technical Progress Report [for] Period Beginning September 1, 1960. (University of Notre Dame, Ind.). [nd.]. Contract AT(11-1)-274. 24p.

A summary is given of the work done on the program directed to the study of fundamental processes connected with the external photoelectric effect in metals and semiconductors. Discussions are presented of specific studies of vectorial photoelectric effect and optical properties of molybdenum, and photoemission from strontium and barium oxides on molybdenum. (B.O.G.)

22822 (UNM-TR-EE-54) A THEORETICAL AND EXPERIMENTAL ANALYSIS OF A HALL GENERATOR IN A NON-UNIFORM MAGNETIC FIELD. Lowell D. Watkins and W. W. Grannemann (New Mexico. Univ., Albuquerque. Engineering Experiment Station). May 1961. For Sandia Corp. 60p. (SCDC-2344)

Equations were developed which give additional insight into the appearance of the electric field in a Hall generator. A theoretical analysis of the behavior of output voltage, input impedance, and voltage gain for a non-uniform magnetic field was made. Experimental data are presented which demonstrate the validity of the theoretical analysis. (auth)

22823 (UNM-TR-EE-55) THEORY AND FABRICATION OF POINT CONTACT DIODES UTILIZING REDUCED SINGLE CRYSTAL RUTILE TiO_2 . Goebel Davis, Jr. and W. W. Grannemann (New Mexico. Univ., Albuquerque. Engineering Experiment Station). May 1961. For Sandia Corp. 66p. (SCDC-2346)

Single crystal rutile TiO_2 upon reduction by heating in an atmosphere of hydrogen becomes a semiconductor, and the conductivity increases with the time and temperature of reduction. The reduction process creates oxygen vacancies with which there are associated two loosely bound electrons. These electrons may be raised to the conduction band by thermal excitation. Hence, an oxygen vacancy behaves like an impurity donor site. Point contact diodes

re made by utilizing reduced single crystal rutile; the laboratory fabrication techniques are described. For optimum rectification action, contact placement must be made on a mechanically undisturbed portion of a crystal formed by cleaving the crystal (after reduction) along a distinct, natural cleavage plane. The volt-ampere averages of four identical diodes were used for curve fitting to the different theoretical models of diode operation. A selection of theoretical models for comparison with the observed phenomena requires that it be determined if minority carrier injection is occurring, and hence, if the system may or may not be regarded as a single-carrier system. A test for minority carrier injection was made by exploring the variation of potential in the neighborhood of a rectifying point contact. For an injecting contact, the local resistivity decreases for increasing forward current flow through the rectifying contact. This phenomena was not observed, and hence, it was concluded that injection is not occurring to an extent which is experimentally detectable. Diode theory and diffusion theory equations for non-injecting contacts were fitted to the experimental data. In the forward direction, the diode theory equation fits the data exceptionally well, and the resultant equation is $I = 1.096 \times 10^{-8} [e^{12.39(V-339.81)} - 1]$ amperes, where V is the external applied voltage in volts. In the reverse direction, the data was fitted to the diode theory equations and diffusion theory equations with Mott barriers and Schottky barriers. Corrections to these equations were made for the tunnel penetration or the image force. The resultant fits indicate (for both diode and diffusion theory) that the rectification phenomena are most likely attributable to a Mott-type barrier in which the image forces reduce the effective barrier height in the reverse direction. (auth)

2824 (WADD-TR-60-699(Vol.V)) ENERGY CONVERSION SYSTEMS REFERENCE HANDBOOK. VOLUME V. DIRECT SOLAR CONVERSION. W. Evans and W. R. Benetrey (Electro-Optical Systems, Inc., Pasadena, Calif.). Sept. 1960. Contract AF33(616)-6791. 206p.

The performance characteristics of the photovoltaic converter when used to convert solar radiation directly to direct electrical energy is described. Empirical and analytical relationships are derived which present expected efficiencies of conversion as a function of temperature, solar insolation, and other factors. The effects of environmental degradation due to meteoroids and the Van Allen belts are discussed. The present and anticipated state-of-the-art of fabrication techniques is presented, along with the advantages of using concentrating mechanisms for increasing the solar illumination level. A discussion is also included describing the state of the art and practical and theoretical limitations of the photo-emissive generator. It does not appear at present that the photo-emissive generator offers competition to the photovoltaic cell. (auth)

2825 (AEC-tr-4481) OSCILLATION MATRICES AND MODELS AND SMALL VIBRATIONS OF MECHANICAL SYSTEMS. Second Edition Corrected and Expanded. F. R. Gantmakher and M. G. Krein. Translated from a Publication of the State Publishing House for Technical-Theoretical Literature, Moscow-Leningrad, 1950. 414p.

A natural mathematical base is proposed for the investigation of the so-called oscillation properties of small harmonic oscillations of linear elastic continua, such as, transverse oscillations of strings, rods, and multiple-span beams, and torsional oscillations of shafts. The book is divided into five chapters: I. general information on matrices and quadratic forms; II. theory of oscillating matrices; III. small oscillations of a mechanical system

with n degrees of freedom; IV. small oscillations of a mechanical system with an infinite number of degrees of freedom; and V. fixed-sign matrices. Appendixes include: a method of approximate calculation of characteristic numbers and eigenvectors of an oscillating matrix; and a solution to the problem of the determination of masses of n beads or their placement on a string for specified frequencies of vibrations of the string. (B.O.G.)

22826 (AEC-tr-4507) THE MAGNETIC PROPERTIES AND STRUCTURE OF MATTER. Ya. G. Dorfman. Translated from a publication of the State Publishing House for Technical-Theoretical Literature, Moscow, 1955. 364p.

The methods and possibilities of solving problems of the structure of matter are discussed. The investigations and discussions are centered around magnetic phenomena and the subjects of research are divided into groups comprising elementary particles, atoms and nuclei, and weakly and strongly magnetic substances. Unsolved problems are emphasized and possible solutions are offered. (J.R.D.)

22827 (CEA-tr-A-811) RECHERCHES SUR LES SCINTILLATEURS FORMES DE SUBSTANCES MINERALES LUMINESCENTES. CAS PARTICULIER DE L'IODURE DE CESIUM. (TRANSDUCTION PARTICIELLEMENT RESUMEE). (Research on Scintillators formed from Luminescent Mineral Substances. Particular Case of CsI (Summary of Translation in Parts)). H. Knoepfel, E. Loeppé, and P. Stoll. Translated into French by R. Carbonnier from *Helv. Phys. Acta*, 30: 521-52(1957). 92p.

The properties of CsI(Tl) as a scintillation material are described. For α particles of 5.3 Mev, a decay time of 0.55 μ sec and a resolving power of 3.5% were measured. The maximum λ_{\max} of the emission is near 5900 Å, and the absolute efficiency η_p of the phosphor is 6.5%. If the melt of pure CsI is superheated in a vacuum and then crystallized, a very effective scintillator results without the addition of any activator. η_p is 9.3% and λ_{\max} is 4100 Å. Experimental results concerning the emission centers of CsI phosphors are recorded in the second part. The decay time and the intensity as a function of temperature for α particle excitation, the excitation function in the ultraviolet region, and spectral emission for ultraviolet and corpuscular excitation of CsI samples of various preparation modes were measured. There is strong evidence that in CsI(Tl) it is not the Tl complexes that act as emission centers, but that iodine vacancies play a predominant role. The Tl ion attracts several iodine ions and forms a Fromherz complex. In this way vacancies in the iodine lattice are formed. The emission of the CsI phosphors is influenced by Tl ions, but the same influence can be observed after the incorporation of iodine molecules. The undisturbed centers are formed by crystallization of the superheated melt in the vacuum. (auth)

22828 (CEA-tr-R-1214) DENSITE DES TRACES DES PARTICULES CHARGEES DANS LES EMULSIONS PHOTOGRAPHIQUES A HAUTE SENSIBILITE. (Density of Charged Particle Tracks in Photographic Emulsions of High Sensitivity). K. S. Bogomolov. Translated into French from *Zhur. Nauch. i Priklad. Fot. i Kinematografii*, 2: 161-5 (1957). 16p.

An experimental and theoretical study was made of the density of weakly ionizing charged particles in highly sensitive nuclear emulsions. The Poisson distribution law was used to calculate the density of the particle tracks. For all the photographic plates studied (P-type plates, experimental plates with reduced sensitivity, stacks of P-type emulsions, and foreign plates as Ilford G-5 and Kodak NT-4), the agreement between theory and experiment was satisfactory. (J.S.R.)

22829 (CEA-tr-X-365) MESURE DE L'ACTIVITE DU TRITIUM GAZEUX. (Measure of Activity of Gaseous Tritium). E. Herczynska. Translated into French from *Nukleonika*, 4: 381-8(1959). 24p.

This study contains a critical review of the methods used for the measurement of the activity of H^3 and a detailed report of a personal effort in this area. The activity of the tritium was measured in tritiated methane in G-M counters with internal filling. The tritiated methane was obtained by the reaction of tritiated water with aluminum carbide, previously purified by heating under vacuum or in free air. At the beginning, counters with zinc chloride cathodes were used, then with graphite external cathodes. The length of the plateau for a G-M counter with external graphite electrode is from 400 to 1000 v. The slope of the plateau was less than 3%/100 v. (tr-auth)

22830 (NP-tr-522) SUPERSONIC VELOCITIES IN HIGH VACUUM. H. Klumb, E. Robens, and O. Scholz. Translated by P. Gottfeldt (U.K.A.E.A. Atomic Energy Research Establishment) from *Naturwissenschaften*, 40: 196-7(1953). 4p.

The design of an apparatus to show the existence of supersonic flows in high-vacuum pumps is described. (J.R.D.)

22831 (NP-tr-594) UKRAINIAN PHYSICS JOURNAL (SELECTED ARTICLES). Translated from *Ukrain. Fiz. Zhur.*, 3: 646-50; 688-9; 693-4(1958). 34p.

Included are translations of three articles, entitled: Adsorption of Barium Atoms and Barium Oxide Molecules on Tungsten; The Problem on the Form in Which Metal-film Cathodes Exist; and Utilizing the Action of a Magnetic Field Upon a Penetrating Plasma in Acquiring Intensive Ionic Beams. A separate abstract was prepared for the third article. (B.O.G.)

22832 (NP-tr-612) CONFERENCE ON EXPERIMENTAL TECHNIQUE AND METHODS IN HIGH TEMPERATURE INVESTIGATIONS, 1956. Translated from *Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovanii*, 1956, Moscow, 1959, p.104-7; 147-56; 224-36; 470-7; 619-35. 130p.

Five papers presented at the Conference on Experimental Technique and Methods in High Temperature Investigations, 1956, are given. A separate abstract was prepared for each paper. (M.C.G.)

22833 (NP-tr-612(p.2-11)) TECHNIQUES IN VAPORIZATION OF REFRACTORY AND CHEMICALLY ACTIVE METALS IN A VACUUM BY MEANS OF A FOCUSED ELECTRON BEAM. M. I. Vinogradov and R. E. (Ye.) Rybchinskii (Rybchinskiy). Translated from p.104-7 of "Soveshchanie po Eksperimental'noi Tekhnike i Metodam Vysokotemperaturnykh Issledovanii, 1956," Moscow, 1959.

An electrostatic vaporizer was designed and constructed for the vaporization of metals in a vacuum by a focused electron beam. A tungsten wire ring cathode, surrounded by focusing electrodes, served as a source of electrons in this vaporizer. In order to improve the focusing of the beam, a negative potential up to 300 v was fed to the focusing electrodes. This apparatus made it possible to vaporize metals such as W, Mo, Ta, Nb, Zr, Ti, and B at a rate of one milligram per second. Prolonged use of the vaporizer with electrostatic focusing demonstrated its satisfactory reliability in operation. The electric field near the vaporizing metal drop was eliminated by using, for the creation of an electron beam, a separate electron gun, the anode of which is under the chamber potential and

removed from the drop. Acceptable results were achieved in curving and focusing a beam with the use of a horizontal magnetic field, in which the beam was bent to an angle close to 180°. Various applications of the vaporizer are discussed. (M.C.G.)

22834 (NP-tr-630) THEORY OF ELECTRON SEMICONDUCTORS. [PART I]. B. I. Davydov and I. M. Shmushkevich. Translated by A. de Merindol (U.K.A.E.A. Atomic Energy Research Establishment) from *Uspekhi Fiz. Nauk*, 24: 21-67(1940). 87p.

A derivation is given of a model for constructing the electron theory of a solid, in which each electron moves independently in a field of force consisting of the field of all the ions or atoms at the crystal lattice points and of the field of all the other electrons, except the given one, averaged over the electron motion. Discussions are included of: the thermal equilibrium of electrons in lattices; the electric conduction of semiconductors in strong and weak fields; and the thermoelectric, thermomagnetic, and magnetoresistive effects in semiconductors with atom and ion lattices. (B.O.G.)

22835 ATOMIC SCATTERING FACTORS OF HELIUM-LIKE SYSTEMS FROM ANALYTIC HARTREE-FOCK WAVE FUNCTIONS. C. M. Womack, Jr., J. N. Silverman, and F. A. Matsen (Univ. of Texas, Austin). *Acta Cryst.*, 14: 744-6(July 1961). (In English)

The most widely used atomic scattering factors are based on numerical Hartree-Fock wave functions, some of which are of low accuracy. Recently a number of analytical Hartree-Fock functions have been published which have a higher accuracy than the older numerical wave functions. By using these analytical wave functions, there are obtained, in turn, analytical expressions for the scattering factors. These expressions can be readily evaluated at any desired interval of $\lambda^{-1} \sin \theta$ with a higher precision than can the numerically integrated scattering factors. The analytical Hartree-Fock scattering factors for the two-electron series to C^{4+} , including the previously unpublished values for H^- and refined values for He, Be^{2+} , and B^{3+} are reported here. In those cases where comparison is possible with recent carefully performed numerical Hartree-Fock calculations (Li^+ and C^{4+}), the agreement is excellent. (auth)

22836 RESOLUTION OF BREMSSTRAHLUNG EXPERIMENTS. H. H. Thies (Univ. of Western Australia, Nedlands). *Australian J. Phys.*, 14: 174-87(Mar. 1961).

A study is made of the means by which mathematical approximations and statistical errors are transmitted into computed cross sections in the analysis of experimental bremsstrahlung yield data. The resolution of bremsstrahlung experiments is defined in analogy with optical resolution and an expression for the practical evaluation of resolution is derived. Methods of cross section computation, and of smoothing and curve-fitting are discussed. (auth)

22837 THE PROBLEM OF A PISTON IN MAGNETIC HYDRODYNAMICS. G. Ya. Lyubarskii and R. V. Polovin (Kharkov State Univ. and Inst. of Physics and Tech., Academy of Sciences, USSR). *Doklady Akad. Nauk S.S.S.R.*, 128: 684-7(1959). (In Russian)

A simple problem of a piston in magnetic hydrodynamics, when the rate of piston motion is constant, is analyzed. The motion of the fluid in front of the piston is more complicated in magnetohydrodynamics than in hydrodynamics. Experiments with semi-space $x > 0$ filled with ideally conducting fluid indicate the presence of only two types of waves: fast and slow shock magneto-sonic waves when the piston moves toward the fluid and fast and slow automodel waves when it moves in the opposite direction. (R.V.J.)

22838 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. PART I. GENERAL ANALYSIS IN THE TIGHT-BINDING FORMULATION. Klaus Ruedenberg (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1861-77(June 1961). (ISC-1061)

The quantum-mechanical treatment is carried through for a set of electrons in a homonuclear conjugated bond system of arbitrary size, including electronic interaction and all overlap effects between neighbors. All framework contributions are obtained by explicit integration over the framework hamiltonian, including the effect of nonconjugated neighbor atoms and differentiating between different types of conjugated atoms (joint, nonjoints, etc.). Expressions are given for the ground-state energy, ionization potential, electron affinity, electronegativity, and for the configuration interaction matrix for the calculation of excited states, assuming singly excited configurations. The results take simple forms permitting instructive interpretations. The partial additivity of one-electron binding-energy contributions, obtained as eigenvalues of topological molecular orbitals, and the approximate validity of the neglect of differential overlap is proved. (auth)

22839 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. II. AUGMENTED TIGHT-BINDING FORMULATION. Klaus Ruedenberg (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1878-83(June 1961).

The analysis of homonuclear conjugated systems is extended to include the interactions between non-neighbor atoms and the variation in the interactions between neighbor atoms. Both kinds of interactions are included as perturbation effects on the tight-binding approximation. The formalism developed for the latter is not complicated and interpretations remain unchanged. Application to benzene and naphthalene illustrates the approach. (auth)

22840 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. III. TOPOLOGICAL MATRIX AS GENERATRIX OF BOND ORDERS. Klaus Ruedenberg (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1884-91(June 1961).

It is shown that in homonuclear conjugated systems the various bond orders and similar quantities can be written as matrix functions of the topological incidence matrix. This entails the existence of a number of useful general relations between these various quantities. The relations include as special cases: Coulson and Rushbrooke's theorem on charge orders in alternants; G. G. Hall's theorem on bond orders in alternants; McWeeny's theorem on the formal charges; Ham and Ruedenberg's correlation between Coulson and Mulliken bond orders for neighbors in alternants; closely related is Ham-Ruedenberg-Platt's relation between valence-bond bond orders and molecular orbital theory. A number of new relations between bond orders are derived and discussed. The generalization from alternants to nonalternants is given particular attention. (auth)

22841 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. IV. INTEGRAL FORMULAS. Klaus Ruedenberg (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1892-6(June 1961). (ISC-1108)

Formulas are established for all carbon and hydrogen penetration integrals occurring in the tight-binding approximation of the theory of mobile electrons. The orbital exponents of the penetrated shielding orbitals may differ from the orbital exponent of the penetrating $2p\pi$ electrons. A simple correlation between kinetic energy integral and overlap integral is found. (auth)

22842 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. V. EMPIRICAL DETERMINATION OF INTEGRALS BETWEEN CARBON ATOMIC ORBITALS FROM EXPERIMENTAL DATA ON BENZENE. Klaus Ruedenberg and E. Miller Layton, Jr. (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1897-1907(June 1961). (ISC-1083)

It is shown that the experimental information given in the uv spectrum of benzene uniquely determines the two-center coulomb integrals between the $2p\pi$ atomic orbitals of carbon as a function of the internuclear distance. The calculations are carried out including all terms involving neighbor overlap. For the many-center electron-interaction integrals, the Mulliken approximation and the London approximation are both considered with little difference in the results. Some peculiar properties of the empirically determined distance dependence are compared with the theoretical behavior of two-center coulomb integrals. The empirical values for the resonance integral and the Coulomb integral are also found. The investigation differs by the inclusion of overlap effects. (auth)

22843 QUANTUM MECHANICS OF MOBILE ELECTRONS IN CONJUGATED BOND SYSTEMS. VI. THEORETICAL EVALUATION OF ENERGY CONTRIBUTIONS. Klaus Ruedenberg (Ames Lab., Ames, Iowa). *J. Chem. Phys.*, 34: 1907-13(June 1961). (ISC-1120)

General formulas are used to analyze the energy contributions of the molecular framework for a π -electron system in detail, without use of additional assumptions. The valence-state potential of carbon, used in the framework potential, and the $2p\pi$ atomic orbitals are determined by a minimum principle. The Coulomb integral and resonance integral are evaluated from their constituent integrals in the tight-binding approximation. The agreement with the empirical values [see K. Ruedenberg, *J. Chem. Phys.* 34: 1878 (1961)] is unsatisfactory for the Coulomb integral but very good for the resonance integral. The approximate proportionality between energy matrix elements and overlap integrals is proven for a variation of the internuclear distance between 1.26 and 1.54 Å. (auth)

22844 EFFECT OF PRESSURE ON THE RESISTANCE OF IODINE AND SELENIUM. A. S. Balchan and H. G. Drickamer (Univ. of Illinois, Urbana). *J. Chem. Phys.*, 34: 1948-9(June 1961).

The effect of pressure from 60 to over 400 kbar was measured on the resistance of Se and I. Selenium exhibits a very rapid drop in resistance between 60 and 128 kbar; at 128 kbar it shows a discontinuous drop. At higher pressures its behavior is apparently metallic. Iodine shows a rapid drop in resistance from 60 kbar to the region of 225 to 255 kbar where there is relatively abrupt change of slope. At higher pressures the change in resistance with pressure is much smaller. The optical energy gap of selenium extrapolates to zero at about 130 kbar, while the optical gap for iodine extrapolates to zero at 240 kbar. (auth)

22845 PARAMAGNETIC SUSCEPTIBILITY OF POLYCRYSTALLINE PRASEODYMIUM METAL. Sigurds Arajs, R. V. Colvin, and J. M. Peck (U. S. Steel Corp. Research Center, Monroeville, Penna.). *J. Chem. Phys.*, 34: 1959-62(June 1961).

Measurements were made between 300 and 1500°K and are in good agreement with the Van Vleck theory of paramagnetism based on a localized f-electron model of noninteracting Pr^{3+} ions. By making a reasonable correction for the contribution of conduction electrons to the paramagnetism, a best fit to the experimental results is obtained by using a screening constant $\sigma = 34$. (auth)

22846 ANALYSIS OF THE ABSORPTION AND FLUORESCENCE SPECTRUM OF NdCl_3 DILUTED WITH LaCl_3 . Eugene Y. Wong (Univ. of California, Los Angeles). *J. Chem. Phys.*, 34: 1989-93 (June 1961).

The Stark splitting of the identified levels of Nd^{3+} in LaCl_3 were calculated by first-order perturbation. Intermediate coupling wave functions and crystal-field interaction parameters reported by Judd were used. (auth)

22847 EVALUATION OF APPROXIMATE ATOMIC WEIGHTS. C. K. Ganguli and S. C. Rakshit (Indian Bureau of Mines, Delhi). *J. Indian Chem. Soc.*, 38: 213-16 (Apr. 1961). (In English)

A semi-empirical equation correlating isotopic mass, mass number, and atomic number is the basis for deriving relations that yield approximate values of atomic weights of 91 elements from helium to uranium from a mere knowledge of the atomic numbers of the elements. (auth)

22848 THE EFFECT OF TEMPERATURE ON XENON INSTABILITY. J. Chernick, G. Lellouche, and W. Wollman (Brookhaven National Lab., Upton, N. Y.). *Nuclear Sci. and Eng.*, 10: 120-31 (June 1961). (BNL-5112)

The space-independent dynamics of a reactor controlled by xenon and temperature effects is investigated. The boundedness of the solutions for a reactor with a prompt, negative flux coefficient is shown. Criteria are developed for reactor stability. The effect of delayed neutrons and of the time lag between power and temperature on xenon stability is considered and shown to be generally negligible. Nonlinear effects are shown to be important for reactors with negative as well as positive temperature coefficients. (auth)

22849 SPHERICAL HARMONIC CALCULATIONS FOR A CYLINDRICAL CELL OF FINITE HEIGHT. N. Tralli and J. Agresta (Nuclear Development Corp. of America, White Plains, N. Y.). *Nuclear Sci. and Eng.*, 10: 132-41 (June 1961).

The spherical harmonic (P_3) approximation to the Boltzmann equation is applied to the case of a finite cylinder, with symmetry about the axis of the cylinder. Solutions are obtained for the case of a neutron source proportional to $\cos B_z Z$ where z is measured along the axis of the cylinder and B_z^2 is the axial buckling. These solutions are then expanded in terms of B_z and only terms of order B_z^2 or less are retained. The approximate solutions are then used to calculate the thermal utilization of a cell of finite height composed of a natural uranium rod surrounded by a D_2O moderator as a function of the axial buckling. The resultant expression for the utilization has the form

$$f(B_z) = f(0)[1 - L^2 B_z^2]$$

where $f(0)$ is the utilization of the cell of infinite height and the constant L^2 corresponds to the thermal diffusion area in two-group theory. Results are obtained for several cells and compared with those obtained using other calculational methods. (auth)

22850 APPLICATION OF RAPID FISSION GAS ANALYSES TO AN OFF-GAS SYSTEM TEST. R. C. Koch, G. L. Grandy, and J. A. Roll (Nuclear Science and Engineering Corp., Pittsburgh). *Nuclear Sci. and Eng.*, 10: 183-9 (June 1961).

Recently developed methods for separation and analysis of radioactive fission gases were applied to obtain data for an off-gas system of an in-pile loop. A separate in-pile test facility was designed to provide a gas transport stream having fission products having concentrations simu-

lating those anticipated in the off-gas system. Characterization of the radioactivities in this facility provided necessary pre-operational information and specifications for operational and analytical procedures for the off-gas system test. (auth)

22851 ELECTRON ENERGY BANDS OF ONE-DIMENSIONAL RANDOM ALLOYS. J. S. Faulkner and J. Korringa (Ohio State Univ., Columbus). *Phys. Rev.*, 122: 390-6 (Apr. 15, 1961). (AFOSR-957)

A method for calculating the density of states for an infinite, one-dimensional random alloy is obtained by investigating the asymptotic behavior of the trace of the "transmission" matrix which relates the values taken on by the wave function and its derivative at either end of the crystal. This matrix can be calculated if the potentials of the constituent A and B atoms, V_A and V_B , are given. The equations are first derived for a very general case, and then the results of a calculation for an alloy in which the A and B atoms have equal concentrations is shown for the case that V_A and V_B are δ -function potentials. Certain generalizations of the method for treating other nonperiodic problems are discussed briefly. (auth)

22852 OBSERVATIONS OF de HASS-van ALPHEN OSCILLATIONS IN p-TYPE PbTe . P. J. Stiles, E. Burstein, and D. N. Langenberg (Univ. of Pennsylvania, Philadelphia). *Phys. Rev. Letters*, 6: 667-9 (June 15, 1961).

The results of the experiment carried out by pulsed magnetic field techniques are presented. Four p-type PbTe samples were studied and over 30 oscillations observed. Three of the samples were cut from a single boule and yielded a hole density of $3 \times 10^{18}/\text{cm}^3$. The fourth yielded a hole density of about $1 \times 10^{18}/\text{cm}^3$. The samples were circular cylinders with the cylinder axis parallel to one of the 3 principal symmetry directions. The successive maxima and minima are plotted vs. B^{-1} for two different orientations and the periods measured in the 3 symmetry directions are listed. The only limitation for sensitivity of this method is that the materials must have $E_F > k(T_b + T_d)$, where E_F is the Fermi energy measured relative to the edge of the band in question. Additional requirements are that the sample be degenerate ($E_F > kT$) and uniform carrier densities and long collision times ($E_F > kT$) are needed. The requirements of a long collision time ($E_F > \hbar/\tau$) is expressed in terms of density and mobility of the carrier as $n^2\mu > 10^{16}$ volt sec for the case of a single spherical energy band. (P.C.H.)

22853 SUPERCONDUCTIVITY AT HIGH MAGNETIC FIELDS AND CURRENT DENSITIES IN SOME Nb-Zr ALLOYS. T. G. Berlincourt, R. R. Hake, and D. H. Leslie (Atomics International, Canoga Park, Calif.). *Phys. Rev. Letters*, 6: 671-4 (June 15, 1961).

The results on Nb-Zr alloys were obtained during investigation of resistive superconducting transitions in certain Ti-, Zr-, Nb-, Hf-, and Ta-rich binary alloys in magnetic fields up to 30 kgauss. The data show that cold-worked Nb-rich Nb-Zr alloys display zero electrical resistance at current densities as high as 10^6 amp/cm² at 30 kgauss and at 4.2°K. Present measurements reveal high-field superconducting effects in cold-rolled Nb-Zr alloys such as a marked dependence of the magnitude of the maximum zero-resistance current upon the direction of the externally applied transverse magnetic field relative to the rolled surface of the specimen, and anomalous increase of the maximum zero-resistance current with increase of magnetic field strength over certain regions in certain alloy specimens. The source materials, method of fabrication, and

cross-sectional dimensions of the specimens are given. (P.C.H.)

2854 SUPERCONDUCTIVITY IN THE NEIGHBORHOOD OF METALLIC CONTACTS. Leon N. Cooper (Brown Univ., Providence). *Phys. Rev. Letters*, 6: 689-90 (June 15, 1961).

A microscopic theory of superconductivity in contact neighborhoods based on a modification of the parameter $(0)V$ which occurs in the previously devised expression for the energy gap $\epsilon = 2(\hbar\omega)_{\text{av}} \exp(-N(0)V)$ is presented. The arguments have as a converse the implication that the contact region of nonsuperconducting materials should become superconducting when in contact with superconductors. The effective penetration of electrons from one region to another is limited among other things by the electron mean free path; the further superconducting electrons penetrate to the "normal area" the smaller the energy gap should be. There should be only one transition temperature for the entire sample. (P.C.H.)

2855 ARTIFICIAL ELECTRON CLOUDS. VI. LOW ALTITUDE STUDY, RELEASE OF CESIUM AT 69, 82, AND 91 km. J. Pressman, F. F. Marmo, and L. M. Aschenda (Geophysics Corp. of America, Boston). *Planetary and Space Sci.*, 2: 228-37 (Aug. 1960).

A series of three artificial electron clouds is reported created at 69, 82, and 91 km by the day-time thermochemical release of Cs. The electron cloud was created by both thermal and photo-ionization. A lower limit for the effective duration of electron clouds for this kind of release was found to be 70 km. The short duration at low altitudes is caused by both the rapid chemical consumption of the Cs atoms thereby preventing photo-ionization and the rapid electron attachment followed by mutual neutralization. The coefficient of mutual neutralization is estimated to be $10^{-7} - 10^{-8} \text{ cm}^3 \text{ sec}^{-1}$. The mathematical model employed appears to be reasonably valid. (auth)

2856 NOTE ON HYDROMAGNETIC WAVES IN AN INCOMPRESSIBLE FLUID CONDUCTOR. John Carstou (Pittsburgh Electronic Systems, Waltham, Mass.). *Proc. Natl. Acad. Sci. U. S.*, 47: 891-9 (June 1961). Results are reviewed from recent studies on hydromagnetic waves. Theories are discussed which have been used to explain ionospheric noise generation and geomagnetic disturbances and that may apply to radiations from natural and artificial sources. A brief systematic account is presented of wave-motion equations employing the rate-of-strain tensor, and a new pseudo-tensor derived from the magnetic field in the same manner as the former is derived from material velocity. Fundamental equations, wave-motion equations for the density and transverse components, equations for the coupling relationship between vorticity and current density, and wave-motion equations employing the new pseudo-tensor are included. (C.H.)

2857 CALCULATION OF THE CONCENTRATION OF EXCITED MOLECULES IN THE ZONE OF STATIONARY ELECTRICAL DISCHARGES. S. S. Vasil'ev (Technological Inst. of Light Industry, Moscow). *Zhur. Fiz. Khim.*, 35: 1-71 (Apr. 1961). (In Russian)

The mutual transitions of excited molecules from one level to another is regarded as a chain process, and the molecules at various excited levels are conceived of as active particles. The kinetic parameters for the case of excited molecules in an electrical discharge may be calculated on the basis of the elementary processes taking place in the discharge. Solutions are discussed for the case of the steady state condition of discharge and three excitation lev-

els of the molecules. The generalized formulas obtained were reduced to a simplified easily perceived form. The simplified relations may be used for the quantitative interpretation of kinetic experiments on the electrical oxidation of nitrogen for various strengths of the discharge current. (auth)

2858 ARTIFICIALLY ANISOTROPIC MEDIA. Ya. B. Fainberg and N. A. Khizhnyak. *Zhur. Tekh. Fiz.*, 25: 711-19 (1955). (In Russian)

Anisotropic media, artificially created by means of isotropic dielectric discs distributed in a smooth metallic waveguide, is studied. Maxwell's equations describing the propagation of axially-symmetric electromagnetic waves are divided into two-independent systems describing E- and H-wave propagations. An analysis is made of E-wave propagation in a smooth cylindrical waveguide filled with a dielectric or a magnetic with dielectric constant $\epsilon(Z)$ or magnetic penetrability periodically varying along the Z axis. The data show that a waveguide filled with dielectric discs is equivalent to a waveguide filled with anisotropic dielectric. (R.V.J.)

2859 COMPOSITION OF EQUILIBRATE BEAM PRODUCED BY SINGLE-CHARGE POSITIVE OXYGEN ION PASSAGE THROUGH GAS TARGETS. Ya. M. Fogel, L. I. Krupnik, A. G. Koval, and R. P. Slabospitskii (Inst. of Physics and Tech., Kharkov). *Zhur. Tekh. Fiz.*, 27: 988-96 (1957). (In Russian)

The charge compositions of the beams produced by 12.3 to 46.2 kev singly-charged positive oxygen ions passing through gas targets of Ne, Ar, H₂, N₂, and O₂ gases were determined. (tr-auth)

2860 TABLES OF RADIAL INTEGRALS OF ATOMIC SPECTRA THEORY. V. V. Vanagas, I. I. Glembockii (J. Glembockij), and K. K. Ushpalis (Uspalis)—A. P. Yutsica (Jucys, ed. Moscow, Computing Center, Academy of Sciences, USSR, 1960. 392p. (In English and Russian).

Tables are given for evaluating two-fold radial integrals from one-electron wave function parameters. The tables are designed for use in approximate atomic quantum theory methods. Methods of obtaining three- and four-fold integrals are shown. Interpolation methods are described, involving Bessel functions. (T.F.H.)

2861 THE PHYSICS OF RADIOLOGY. Second Edition. Publication Number 419, American Lecture Series. Harold Elford Johns. Springfield, Ill., Charles C. Thomas, 1961. 783p.

The physical and medical aspects of radiology are examined. The production and properties of x radiation, as well as basic aspects of nuclear physics, are reviewed. High energy and teletherapy machines (1 to 3 Mev) are discussed, including accelerators and isotope sources. Absorption, measurement, dosage, and quality of x radiation are studied. Clinical applications, such as rotation therapy, radium and radioisotope uses, and diagnostic radiology, are investigated. Attention is given to radiation protection and radiobiology. (T.F.H.)

2862 THE QUANTUM MECHANICS OF MANY-BODY SYSTEMS. D. J. Thouless. Pure and Applied Physics. A Series of Monographs and Textbooks. New York, Academic Press, 1961. 182p. \$5.50.

A unified introduction to many-body theory in nuclear physics, atomic physics, and the electron theory of metals is presented. Chapters are included on soluble models, vibrational methods, perturbation theory, excited states, superconductivity theory, finite temperatures, and bosons. A familiarity with non-relativistic quantum mechanics and statistical mechanics is assumed. (D.E.B.)

22863 PROGRESS IN SOLID MECHANICS. VOLUME II. I. N. Sneddon and R. Hill, eds. Amsterdam, North-Holland Publishing Company, 1961. 341p.

The mathematical theory and experimental procedures of elasticity and plasticity of solids are presented. The following topics are described and discussed: large elastic deformations, elastic waves in anisotropic media, elastic inclusions and inhomogeneities, plastic waves, measurement of dynamic elastic properties, discontinuity relations in mechanics of solids, and stability of elastic-plastic structures. (N.W.R.)

Astrophysics and Cosmology

22864 (AFOSR-885) PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON ANALYTICAL ASTRODYNAMICS AT THE UCLA CAMPUS, LOS ANGELES, CALIFORNIA, JUNE 27-JUNE 29, 1961. (General Electric Co. Missile and Space Vehicle Dept., Philadelphia; Air Force Office of Scientific Research, Washington, D. C.; and California. Univ., Los Angeles). Contract AF 49(638)-814. 98p.

Abstracts of work presented orally are given. The speakers described results of new research along with published work and possible approaches to new problems. Included are sections on earth satellites, critical inclination, interplanetary trajectories, optimization, orbit determination, physical problems, and analytical problems. (J.R.D.)

22865 (NP-10267) ASTRONAUTICS INFORMATION. OPEN LITERATURE SURVEY, VOL. III, NO. 5, ENTRIES 30,845-31,145. E. M. Carringer, M. G. Hoppe, and B. H. Nichols, comps. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). May 1961. Contract NASw-6. 61p.

An open literature survey dealing with astronautics covering the period of May, 1961 is presented. Three hundred references with abstracts are listed. An index of periodicals, an author index, and a subject index are included. (M.C.G.)

22866 (NP-10288) ASTRONAUTICS INFORMATION. Open Literature Survey, Vol. III, No. 4 (Entries 30,625-30,844). E. M. Carringer, M. G. Hoppe, and B. H. Nichols, comps. (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Apr. 1961. Contract NASw-6. 45p.

22867 (NP-tr-618) VARIABLE PROCESSES IN SOLAR FLARES AS A PHENOMENON OF PINCH-EFFECT. A. B. Severny (Severnny). Translated from Astron. Zhur., 35: No. 3, 335-50(1958), 33p.

This paper was previously abstracted from the original language and appears in *NSA*, Vol. 13, abstract no. 19495.

22868 (TG-230-T228) EFFECT OF GEOMAGNETIC DISTURBANCES ON THE DRIFT OF IONIZED GAS IN THE UPPER ATMOSPHERE. V. P. Dokuchaev. Translated by R. P. Illwitzer from Izvest. Vysshikh Ucheb. Zavedenii, Radiofiz., 3: 901-3(Sept.-Oct. 1960). 4p.

A quantitative examination was made of the effects of the electrical field of a magnetohydrodynamic disturbance which causes an ionized gas to drift. Drift velocity calculations were made for the E-layer and the F-layer, and the results were compared with experiment. (B.O.G.)

22869 DEUTERONOMY. SYNTHESIS OF DEUTERONS AND THE LIGHT NUCLEI DURING THE EARLY HISTORY OF THE SOLAR SYSTEM. William A. Fowler, Jesse L. Greenstein, and Fred Hoyle (California Inst. of Tech., Pasadena). *Am. J. Phys.*, 29: 393-403(July 1961).

Abundances in terrestrial and meteoritic matter indicate

that the synthesis of deuterons and of the lithium, beryllium, and boron isotopes occurred during an intermediate stage in the early history of the solar system. In this intermediate stage, the planetary material was largely, but not completely, separated from the hydrogen that was the main constituent of primitive solar material. Appropriate physical conditions were satisfied by solid planetesimals with dimensions of the order of 10 m, consisting of silica and oxides of the metals embedded in an icy matrix. The synthesis occurred through spallation and neutron reaction induced in the outer layers of the planetesimals by the bombardment of high-energy charged particles accelerated in magnetic flares at the surface of the condensing sun. The importance of the (n,α) reactions on Li^6 and B^{10} is indicated by the relatively low abundances of these two nuclei. Anomalous abundances of Xe^{129} and Ag^{107} observed in meteorites can be attributed to the decay of radioactive I^{129} and Pd^{107} produced in the planetesimals. The interval between the irradiation of the small planetesimals and the formation of large bodies in the solar system did not exceed 10^7 to 10^8 years. (auth)

22870 ARTIFICIAL ELECTRON CLOUDS. IV. THERMAL IONIZATION STUDY, NIGHT TIME CESIUM RELEASE AT 101 km. J. Pressman, F. F. Marmo, and L. M. Aschenbrand (Air Force Cambridge Research Center, Bedford, Mass.). *Planetary Space Sci.*, 2: 17-25 (Oct. 1959).

Radio-radar and optical observations are reported of an electron cloud created by the night time release of cesium at 101 km from a Nike-Cajun rocket on 20 May 1958. An analysis of the electron yield based upon thermochemistry along with the Saha relationship, indicates that the electrons observed can be ascribed to thermal ionization. (auth)

22871 ARTIFICIAL ELECTRON CLOUDS. V. MORNING TWILIGHT STUDY, RELEASE OF CESIUM AND SODIUM AT 128 AND 116 km. F. F. Marmo, J. Pressman, E. R. Manring, and L. Aschenbrand (Geophysics Corp. of America, Boston). *Planetary Space Sci.*, 2: 174-86(Apr. 1960).

The results and analysis were reported of two rocket experiments designed to study the simultaneous optical and radio-radar behavior of artificial electron clouds. The optical properties were obtained by "doping" the cloud with a small percentage of sodium in one experiment and by using a complete payload of sodium in another. These experiments were performed with Nike-Cajun rockets under morning twilight conditions on 21 and 22 May 1958, respectively. Analyses were made of radar slant range behavior with time, optical growth rate and variation of critical frequency with time. In the last, a more advanced analysis was used that allowed for the differential diffusion of charged and neutral particles. The results from these analyses were compared to the estimated atmospheric properties and to thermo-chemical release properties. This study indicated the utility of combined radio-radar and optical observations. Values were derived for the following parameters: neutral and ambipolar diffusion coefficients, chemical yield, thermal ionization efficiency, wind velocity, and wind shear. (auth)

22872 PHYSICS OF THE SOLAR CHROMOSPHERE. Richard N. Thomas and R. Grant Athay. Interscience Monographs and Texts in Physics and Astronomy. Volume VI. New York, Interscience Publishers, Inc., 1961. 431p. \$15.50.

The properties of the solar chromosphere and of the stellar atmosphere in general are studied. A non-local-

thermal-equilibrium (non-LTE) methodology is used to study the chromospheric structure variations, mass motions, and other data. A chromospheric model is developed, based on statistical and spectroscopic correlations. This model is used to explain the H, He, optical continuum, and radio emission spectra from the sun. (T.F.H.)

Cosmic Radiation

22873 (AFOSR-877) GEOMAGNETICALLY TRAPPED ELECTRONS FROM COSMIC RAY ALBEDO NEUTRONS.

M. Lenchek and S. F. Singer (Maryland. Univ., College Park). May 1961. Contract AF-49-(638)530. 61p. The ability of the cosmic ray neutron albedo mechanism to account for geomagnetically trapped electrons was investigated quantitatively. Injection as a function of energy, pitch angle, and altitude was computed from a reasonable neutron albedo model. Loss mechanisms (slowing down and pitch angle diffusion) based on Coulomb interactions with the residual atmosphere were considered to act both independently and simultaneously. It was found that slowing down is generally dominant. The electron belt which resulted had the following features: an intensity whose energy spectrum shows a sharp peak at ~ 200 kev, an angular distribution which is approximately "isotropic" up to the loss energy and an omnidirectional, integral intensity in the geomagnetic equatorial plane which is approximately constant with altitude. These results agree only poorly with spectrometer observations which show an intensity spectrum with a peak at a much lower energy or no peak at all. However, the quantitative agreement as to intensity is good at energies ≥ 400 kev. Assumptions concerning the atmospheric model seriously affect the results. This relationship is analyzed in some detail. The effect of the Capetown magnetic anomaly was investigated and shown to produce a "slot" of only 2% in the equatorial plane. It is concluded that only a small fraction of the trapped electrons can be accounted for in terms of neutron albedo, essentially all trapped electrons > 400 kev. An "auroral" component of low energy electrons is also present. The energy of this low energy component probably derives from local acceleration, and ultimately from the sun. (auth)

22874 (LA-2507) GAMMA-RAY MEASUREMENTS IN AND ABOVE THE ATMOSPHERE. J. A. Northrop (Los Alamos Scientific Lab., N. Mex.). Dec. 1960. Contract -7405-ENG-36. 48p.

Two stage sounding rockets were used to carry phoswich-ray spectrometers to an altitude of 75 miles. The instrument head weighed 12.1 lb and the attached rocket 7.5 lb. About 1.3 gm cm^{-2} aluminum surrounded the detector over most of the effective 4π solid angle. The $1\frac{3}{4}$ in. \times $1\frac{3}{4}$ in. CsI(Tl) crystal encased in a $\frac{1}{8}$ in. plastic scintillator jacket was used to detect the amplitude of individual γ -ray scintillations (0.3 to 3.0 Mev) in the CsI and the rejection of charged particles in the plastic. The information was transmitted to the ground by standard FM-FM telemetry. The maximum flux occurs at 53,000 ft with representative integral counting rates: $E_\gamma > 0.3$ Mev, 185 sec^{-1} ; > 0.6 Mev, 105 sec^{-1} ; and > 1.0 Mev, 45 sec^{-1} . The counting rate is constant at all altitudes above 120,000 ft: 64, 32, and 11 sec^{-1} at the three biases, respectively. The charged-particle counting rates (energy in the plastic > 0.3 Mev) are 2 sec^{-1} at the atmospheric maximum and 38 sec^{-1} above the atmosphere. The differential spectrum above the atmosphere was examined for the presence of a 2.23 Mev peak. An upper limit for this flux from the sun is $0.5 \text{ photons cm}^{-2} \text{ sec}^{-1}$. (auth)

22875 (NP-10289) ANALYSIS OF BALLOON OBSERVATIONS DURING THE APRIL 1960 SOLAR COSMIC RAY EVENTS. Andrew J. Masley (Minnesota. Univ., Minneapolis. School of Physics). Apr. 1961. 54p. (CR-35)

Measurements of the different decay rates and absolute intensities of solar cosmic rays by the space probe, earth satellite, and balloons were made during the April 1 event. The integral energy power spectrum exponents were determined on April 1 to be $\gamma = 2.4$ from 400 to 160 Mev. The neutron monitor decreases during the Forbush decrease and recovery are discussed. The modulations in intensity and I/I_{\min} observed during the April 28 event are consistent with a 50-Mev cutoff change from 140 to 90 Mev. Results of special chamber flights showed recombination of cosmic rays to be very small. (D.L.C.)

22876 (JPRS-8224) RELATIONSHIP BETWEEN CHARGED PARTICLE MEASUREMENTS BY SOVIET COSMIC ROCKETS AND MAGNETIC FIELD MEASUREMENTS BY EXPLORER VI AND PIONEER V. K. I. Gringauz and S. M. Rytov. Translated from Doklady Akad. Nauk S.S.S.R., 135: No. 1, 48-51 (Nov.-Dec. 1960). 6p.

Considerations are given showing the agreement which exists between the results of measurements obtained by electrode traps in Soviet space rockets and magnetometers on Explorer VI and Pioneer V. (JPRS)

22877 PROBABILITY OF UNUSUAL ELEMENTS IN VERY BIG SOLAR FLARES CONNECTED WITH COSMIC RAY BURSTS. S. L. Malurkar (Colaba Observatory, Bombay). Acta Phys. Acad. Sci. Hung., 12: 359-60 (1960). (In English)

The possibility of the presence of strontium and barium atoms in the large solar flares connected with cosmic ray bursts was discussed on the basis of data on all solar flares from March 1940 to September 1957. (J.S.R.)

22878 NUCLEAR EMULSIONS IN THE I.G.Y. C. J. Waddington (Bristol Univ., Eng.). J. Phot. Sci., 8: 41-7 (Mar.-Apr. 1960).

The principal use of nuclear emulsions during the IGY was to monitor the α -particle component of the primary cosmic radiation. The reasons for selecting this component of the radiation are discussed, and details are given of the results already obtained from this material. (auth)

22879 SOLAR RADIO BURSTS AND COSMIC RAYS. A. R. Thompson and A. Maxwell (Harvard Coll. Observatory, Fort Davis, Tex.). Planetary Space Sci., 2: 104-9 (Apr. 1960).

An investigation is made of the hypothesis that fast drift (Type III) solar radio bursts are generated by the emission of solar particles with velocities approaching those of cosmic rays. An examination of cosmic ray intensity and solar radio data over the two-year period from October 1956 to September 1958 shows no correlation between these fast drift bursts and cosmic ray increases on the earth. Solar flares, with which fast drift bursts are associated, also appear to be unrelated to cosmic ray increases. On the other hand there are a number of cases of increases in low energy cosmic ray particles, recorded by equipment in satellites and balloons, which are probably related to outbursts of solar continuum (Type IV) radiation. Forbush type decreases in cosmic ray intensity, and accompanying magnetic storms, are regularly preceded by slow drift (Type II) radio bursts. (auth)

22880 SIDEREAL ANISOTROPY OF HIGH ENERGY COSMIC RAYS. [PART] II. I. Escobar V., N. Nerurkar, and R. Weil (Laboratorio de Fisica Cosmica de Chacaltaya,

U.M.S.A., La Paz, Bolivia and Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). *Planetary Space Sci.*, 2: 187-92(Apr. 1960).

Results obtained from the operation of an extensive shower monitor at Chacaltaya, Bolivia are reported. The results show a variation of the order of 1% at 19:00 local Sidereal Time for the high energy showers, and no variation for the lower energy showers recorded. It is shown that the pressure correction applied does not affect these results. (auth)

Criticality Studies

22881 MEASUREMENTS OF THE REACTION RATE DISTRIBUTION PRODUCED BY A SOURCE OF 14 MeV NEUTRONS AT THE CENTRE OF A URANIUM METAL PILE. J. W. Weale, H. Goodfellow, M. H. McTaggart, and M. L. Mullender (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). *Reactor Sci. and Technol.*, J. Nuclear Energy, Pts. A and B, 14: 91-9(May 1961).

Measurements were made of the 14-Mev flux, the total neutron leakage, and the reaction rate distributions for $U^{235}(n,f)$, $U^{238}(n,f)$, $U^{238}(n,\gamma)$, and $Pu^{239}(n,f)$ in uranium piles of density 16.3 g/cm³ and total weight up to 20 tons. (auth)

22882 THE INTERACTION OF 14 MeV NEUTRONS WITH URANIUM. K. W. Allen, P. Bomyer and J. L. Perkin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). *Reactor Sci. and Technol.*, J. Nuclear Energy, Pts. A and B, 14: 100-6(May 1961).

The multiplication of 14-Mev neutrons in uranium shells was studied. The measurements lead to a value of η , the average number of neutrons produced per inelastic collision of a 14 Mev neutron, of 3.30 ± 0.15 . Neutron interactions in a thick uranium shell have also been investigated and effective cross sections for the reactions $U^{238}(n,f)$, $U^{235}(n,f)$, and $U^{238}(n,\gamma)$ have been obtained for the inelastic neutron spectrum in the shell. The value of η , combined with other nuclear data, leads to the following cross section data for U^{238} for neutrons in the energy range 13.4 to 14.8 Mev: $1.1 \pm \sigma_{n,3n} \geq 0.8$ barn and $0 \leq \sigma_{n,n'} \leq 0.3$ barn. (auth)

22883 MINIMUM CRITICAL MASS IN VARIABLE DENSITY AND EPITHERMAL REACTORS. Mathew M. Shapiro (Nuclear Development Corp. of America, White Plains, N. Y.). *Nuclear Sci. and Eng.*, 10: 159-62(June 1961). (NDA-15E-7)

For thermal reactors and those described by two neutron energy groups it is shown that the adjoint fluxes of multi-group diffusion theory can be expressed as linear combinations of the neutron fluxes even when the moderator density is a function of position. For the case of thermal reactors it is shown that minimum critical mass and constant thermal flux in the core are equivalent. (auth)

Elementary Particles and Radiations

22884 (AFOSR-567) ON THE ENERGY LOSS AND SPECIFIC IONIZATION OF A RELATIVISTIC PARTICLE IN A POLARIZABLE MEDIUM. Final Report. P. Budini, L. Taffara, and C. Viola (Trieste. Università). Jan. 31, 1961. Contract AF61(052)-211. 72p.

The dispersive and absorptive properties of a given medium are studied to deduce formulas for use in the theory

of energy loss suffered by an ionizing particle traversing the medium and of ionization produced by it in the medium. Specific energy loss is calculated for electrons and positrons in H and He at different pressures and at liquid state to put in evidence the different behavior of the two particles. A study was made of primary specific ionization and a theory is given for the calculation of ionization of the further generations. Summing the results, total specific ionization can be calculated. The results are applied to some particular cases and compared with experimental results. Work was conducted on the problem of mixtures of elements. In this case a new effect is theoretically foreseen which should be caused by the reabsorption by one of the components of the mixture of Čerenkov radiation emitted by the other. This effect could give a pronounced enhancement of relativistic increase of primary specific ionization as it is shown in two particular cases. (auth)

22885 (CERN-61-11) THE SCATTERING OF POSITIVE 120 MEV PIONS ON PROTONS. PART I. A. Loria, P. Mittner, R. Santangelo, I. Scotoni, and G. Zago (Padua. Università. Istituto di Fisica and Italy. Istituto Nazionale di Fisica Nucleare, Padua). PART II. B. Aubert, A. Brenner, Y. Goldschmidt-Clermont, F. Grard, G. R. Macleod, A. Minguzzi-Ranzi, and L. Montanet (European Organization for Nuclear Research, Geneva). Apr. 11, 1961. 70p.

An investigation of the elastic scattering of 120 Mev positive pions by protons is described in which a liquid propane chamber was exposed to the CERN 600 Mev synchrocyclotron. The results refer to 5405 selected events in which the contamination from scattering on carbon nuclei is shown to be negligible. The values obtained for the phase shifts are: $\alpha_{31} = -2.60^\circ \pm 0.69^\circ$, $\alpha_3 = -11.05^\circ \pm 1.32^\circ$, $\alpha_{33} = +31.67^\circ \pm 0.01^\circ$. The value of α_3 differs significantly from that expected if the linear dependence of α_3 on the momentum, which has been proposed by some authors, is assumed. (auth)

22886 (JEN-82-DF/I-24) METODO DE COINCIDENCIAS β - γ . (A β - γ Coincidence Method). F. Agullo (Spain. Junta de Energía Nuclear, Madrid). 1960. 18p.

A β - γ coincidence method for absolute counting is given. The fundamental principles are revised and the experimental part is detailed. The results from Au^{198} irradiated in the JEN-1 swimming pool reactor are given. The maximal accuracy is 1%. (auth)

22887 (NAA-SR-Memo-6268) EFFECT ON RESONANCE ESCAPE PROBABILITY OF NON-UNIFORM SPATIAL DISTRIBUTION OF RESONANCE NEUTRONS. E. U. Vaughan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 14, 1961. 12p.

The spatial distribution of neutron slowing down in the moderator of a reactor lattice was calculated in order to obtain an integral equation to determine the resonance escape probability of the lattice. In the case of a thermal reactor, for which the resonance capture is small, this equation can be solved by successive approximations. The first approximation is the usual expression for $p(r)$ in terms of the effective resonance integral. The second approximation then provides a correction for the effect of non-uniform spatial distribution of resonance neutrons in the moderator. The function $F(r,a)$, which appears as the kernel of the integro-differential equation, and is needed in the second approximation to the solution, is discussed, and found to require further investigation. (auth)

2888 (NP-10268) NEUTRON TRANSPORT WITH ANISOTROPIC SCATTERING. Janusz R. Mika (Michigan Univ., Ann Arbor). May 1961. 38p.

The general procedure of solving the one-velocity Boltzmann equation in the case of plane geometry is presented for the anisotropic scattering case. It is assumed that the scattering function can be expanded into a finite series of Legendre polynomials. The complete set of eigenfunctions of the Boltzmann equation is found. The orthogonality and completeness of the eigenfunctions are proved. By way of illustration, solutions of some basic problems of neutron diffusion are given. (auth)

2889 (NP-10298) ANGULAR DISTRIBUTION IN $\mu + \nu$ DECAY. E. Frota-Pessôa and N. Margem (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). 1960. 10p. (Notas de Fisica Vol. VI, No. 18, p.379-87).

The data of Auslander et al on the angular distribution of $\mu + \nu$ decays are analyzed with a new scanning method which minimizes error due to loss of decay events at small angles. No back-forward asymmetry was found, in contradiction to earlier observations. (D.L.C.)

2890 (NP-10354) DEUTERON COMPTON EFFECT. Technical Report No. 25. Roger S. Jones (Illinois. Univ., Urbana). June 1961. Contract Nonr-1834(05). 136p.

The neutron Compton effect and the methods of combining the neutron and proton amplitudes in the bound deuteron by means of the impulse approximation were studied by measurements of the deuteron Compton effect. The two principal experimental difficulties were separating elastic and inelastic deuteron events and distinguishing the Compton events from those caused by neutral pion production in deuterium. The equipment for the experiments consisted of a deuterium target in which the Compton scattering of gamma rays in the betatron bremsstrahlung beam occurred, a lead glass Cherenkov counter, a deflecting magnet for momentum analysis of the recoil deuterons, and a deuteron detection telescope consisting of two plastic scintillation counters. The differential cross section of the Compton effect was measured in four runs. First with the magnet at 0° , the betatron was run at 200 and 225 Mev. Then with the magnet rotated to 35° , the betatron settings were 225 and 250 Mev. The results are given in tables and in graph form. A comparison was made of the experimental results and theoretical calculations. The large increase with energy above 200 Mev was found as it was for the proton, indicating that the neutron has a quite similar amplitude. The observed angular and energy dependence seemed to indicate that the impulse approximation is valid and that the "sticking factor" is quite accurate for this process. (M.C.G.)

2891 (NYO-9745) LOCAL FIELDS WITH TERMINATING EXPANSIONS. K. Bardakci and E. C. G. Sudarshan (Rochester, N. Y. Univ.). June 2, 1961. Contract T(30-1)-875. 12p.

The quantum theory problem of constructing explicitly a local Lorentz invariant model field theory which has an asymptotic particle interpretation and gives rise to an S matrix different from unity is discussed. It is proved that a local covariant field $H(x)$ has a complete current, the matrix associated with this field is identically equal to unity. Results show that in order to get an interaction, the current is not allowed to have a terminating expansion in terms of a free field. The absence of a finite connection between a free field and an interacting field tended to confirm the belief that in local quantum field theories with particle interpretation the requirement of the existence of scattering forces in the physical states are such that it is not possible

to identify them with a linear space spanned by "free" particle states. (M.C.G.)

22892 (TID-13044) POLARIZATION OF D-D NEUTRONS FOR DEUTERON ENERGIES FROM 1.9 TO 11 MEV. P. S. Dubbeldam and R. L. Walter (Wisconsin. Univ., Madison). [1960]. Contract AT(11-1)-GEN-7. 24p.

The polarization of neutrons produced in the $D(d,n)He^3$ reaction was measured from 1.9 to 11 Mev by employing the technique of rotating the polarization vector with a magnetic field, the neutron detectors remaining fixed. Helium, contained under high pressure in a thin-walled cell, served as the analyzer. The background counts were reduced by observing coincidences between the helium recoils and the scattered neutrons. The polarization at 45° c.m. reaction angle was found to vary monotonically from -0.12 ± 0.02 at 1.9 Mev to $+0.30 \pm 0.05$ at 11 Mev, changing sign at about 4.2 Mev. At several energies angular distributions of the polarization were measured. (auth)

22893 (UCRL-9656) LOW-ENERGY PION-PHOTON INTERACTION: THE $(2\pi, 2\gamma)$ VERTEX (thesis). Bipin R. Desai (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 20, 1961. Contract W-7405-eng-48. 57p.

In the $(2\pi, 2\gamma)$ problem, the Mandelstam representation is written for the two independent gauge-invariant amplitudes. On the basis of unitarity limitations on the asymptotic behavior of these amplitudes, only a $j = 1$ subtraction in the $\gamma + \pi \rightarrow \gamma + \pi$ channel and a $j = 0$ subtraction in the $\gamma + \gamma \rightarrow \pi + \pi$ channel are allowed. No over-all subtraction constants are required and the Thomson limit is automatically maintained. Only the effect of 2π intermediate states is considered. The off- j $\pi\pi$ contribution involves the amplitude for the process $\gamma + \pi \rightarrow 2\pi$ analyzed by Wong and shown to be proportional to a pseudo-elementary constant Λ . Even with a $\pi\pi$ P resonance, the correction is negligible ($<1\%$) if the value of Λ estimated by Wong on the basis of π^0 decay and confirmed by Ball in connection with photopion production on nucleons is used. A moderately important contribution comes from the S-wave interaction. For the $\pi\pi$ coupling constant λ or order -0.20 , this effect is $\sim 10\%$ in $\gamma + \pi \rightarrow \gamma + \pi$ scattering. For $\gamma + \gamma \rightarrow \pi + \pi$, the correction for the $I = 0$ state at threshold is positive and $\sim 100\%$ of the Born approximation. However, as the energy is increased, the correction quickly changes sign. The $\pi\pi$ S-wave phase shifts needed in the above calculations are obtained by using crossing symmetry relations given by Chew and Mandelstam. For a $\pi\pi$ P-resonance position $\approx 20\mu^2$ (μ being the pion mass), λ in the interval $(-0.20, -0.15)$ is found to be in good agreement with the S-wave enhancement observed by Abashian et al. in $p + d$ collisions. The S-wave interaction is found to be much stronger in the $I = 0$ state than in the $I = 2$ state. (auth)

22894 SOME MEASUREMENTS OF THE ABSORPTION OF 4 MV X RAYS IN CONCRETE. David Greene and John B. Massey (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 34: 389-91 (June 1961).

Measurements were made on the absorption, in concrete, of the primary and secondary radiation from a 4 Mv linear accelerator. The results give tenth-value layers for primary and secondary radiation of 12 in. and 9 in. respectively, in concrete of density 2.2 g/cc. The distribution of tube leakage radiation, and of secondary radiation scattered from a phantom in the beam have also been examined, and it is shown that scattered radiation is only significant in the forward direction. (auth)

22895 THE ISOREPRESENTATIONS OF LEPTONS. J. Lukierski (Univ. of Wrocław, Poland). Bull. acad.

polon. sci., Sér. sci., math., astron. et phys., 8: 553-7 (1960). (In English)

Two schemes for representation of the isoproperties of leptons are presented, in which the lepton strangeness is taken to be 0, and the existence of two types of neutrinos is assumed. The schemes are developed in 3-space, but it is noted that the treatment may be extended to 4-space. Applications of these schemes to electromagnetic and weak interactions are shown. (T.F.H.)

22896 PRODUCTION AND DETECTION OF A POLARIZED DEUTERON BEAM USING THE ATOMIC BEAM MAGNETIC RESONANCE METHOD. V. W. Hughes, C. W. Drake, Jr., D. C. Bonar, J. S. Greenberg, and G. F. Pieper (Yale Univ., New Haven). *Helv. Phys. Acta, Suppl.* VI, 89-107 (1960). (In English)

An apparatus is described by which a completely polarized beam of deuterons may be produced. The deuterons are produced in a Wood's discharge tube, and are polarized by the atomic beam magnetic resonance method. The polarized beam is then ionized by electron bombardment. An electrostatic accelerator is used to accelerate the deuterons to their final energy. The deuteron polarization may be tested by the reaction $T(d,n)He^4$. A polarized D^+ current of about 20 $\mu\mu$ a is produced, with a background D_2^+ unpolarized current of about 200 $\mu\mu$ a. (T.F.H.)

22897 ON MULTIPLE SCATTERING CORRECTIONS FOR COLLIMATORS. Per Chr. Hemmer. *Kgl. Norske Videnskab. Selskabs, Forh.*, 33: 79-82 (1960). (In English)

An approximation in closed form is obtained by minimizing the probability density with respect to X_1 . The exclusion of tracks is performed where it is most effective. (P.C.H.)

22898 MEASUREMENT OF THE X-RAY SPECTRUM WITH A SCINTILLATION SPECTROMETER. II. SCATTERED X-RAYS. C. Takei (Nagasaki Univ.). *Nippon Igaku Hoshasen Gakkai Zasshi*, 19: 1272-7 (1959).

The scattered rays from a lead block consist principally of secondary fluorescent radiation. Those from iron, concrete, plywood, and the body of a mouse, however, were mainly from the Compton effect. From the spectra, scattered x-ray doses were calculated. The dose increased as the voltage in the tube terminal increased. Scattered radiation from the surface of iron was less than that from lead or the mouse. (*Abstr. Japan Med.*, 1: No. 8; 1961)

22899 THE SINGLE-SCATTERING APPROXIMATION TO THE SOLUTION OF THE GAMMA-RAY AIR-SCATTERING PROBLEM. D. K. Trubey (Oak Ridge National Lab., Tenn.). *Nuclear Sci. and Eng.*, 10: 102-16 (June 1961).

The results of a calculation using the single-scattering approximation, with no exponential attenuation or buildup, is compared to results of a Monte Carlo calculation of the dose rate and number flux in air from a monoenergetic gamma-ray source. The comparison shows that the simple approximation is generally adequate for unshielded detectors. (auth)

22900 STUDY OF RESONANCES OF THE Σ - π SYSTEM. Margaret H. Alston, Luis W. Alvarez, Philippe Eberhard, Myron L. Good, William Graziano, Harold K. Ticho, and Stanley G. Wojcicki (Univ. of California, Berkeley). *Phys. Rev. Letters*, 6: 698-702 (June 15, 1961).

The investigation of K^- -p interaction at 1.15 BeV/c in the LRL 15-in. hydrogen bubble chamber was made in order to study events in which a Σ is observed. The total cross sections for the interactions are given with only statistical errors indicated. (P.C.H.)

22901 SIGMA DECAY MODES OF PION-HYPERON RESONANCES. Pierre Bastien, Massimiliano Ferro-Luzzi, and Arthur H. Rosenfeld (Univ. of California, Berkeley). *Phys. Rev. Letters*, 6: 702-5 (June 15, 1961). (UCRL-9693)

A total of 249 three-body reactions of the type $K^- + p \rightarrow \Sigma^+ + \pi^- + \pi^0$ and $K^- + p \rightarrow \Sigma^- + \pi^+ + \pi^0$ at incident K^- momenta of 760 and 850 MeV/c were analyzed during a study of K^- -p interactions in the LRL 15-in. hydrogen bubble chamber. The resonant pion-hyperon state Σ , exists in these reactions and influences reactions such as $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$. (P.C.H.)

22902 INVERSE PHOTOPRODUCTION REACTION $\pi^- + p \rightarrow \gamma + n$ IN FLIGHT. G. Gatti, P. Hillman, W. C. Middelkoop, T. Yamagata, and E. Zavattini (CERN, Geneva). *Phys. Rev. Letters*, 6: 706-8 (June 15, 1961).

The absolute value of the cross section for the process $\pi^- + p \rightarrow \gamma + n$ from which the free-neutron photoproduction cross section is immediately calculable using the principle of detailed balance was measured. The experiment was performed at 90° C.M. angle and a pion energy of 72 MeV. The cross section was measured by detecting the neutrons in a plastic scintillation counter. The energy of the neutrons was measured by time of flight in order to discriminate against the charge-exchange reaction $\pi^- + p \rightarrow \pi^0 + n$. (P.C.H.)

22903 COUPLED S- AND P-WAVE SOLUTIONS FOR PION-PION SCATTERING. B. H. Bransden and J. W. Moffat (CERN, Geneva). *Phys. Rev. Letters*, 6: 708-10 (June 15, 1961).

A numerical iteration of a set of coupled equations is presented where couples S and P waves are treated, and all but two-pion exchange mechanisms are neglected. Up to and including P waves, two S-wave subtraction constants occur, $a_0^1 = A_0^1(-\frac{2}{3})$, one P-wave subtraction constant, $a_1^1 = A_1^1(-\frac{2}{3})$, and a constant ξ , generated by the P-wave threshold behavior. Five equations previously derived where D and higher waves are small are used extensively in the calculations presented. (P.C.H.)

22904 APPROXIMATE SOLUTION OF THE BETHE-SALPETER EQUATION FOR TWO FERMIONS. Masaaki Kawaguchi (Tokyo Univ.). *Progr. Theoret. Phys. (Kyoto)*, 25: 178-88 (Feb. 1961).

The eigenfunction and the binding energy of the ground state are obtained for a bound state of two fermions, which interact through photons or scalar photons in the ladder approximation. The Bethe-Salpeter equation is separated into four independent sets of equations by applying the Tani-Foldy-Wouthuysen transformations. These equations are further simplified by neglecting part of the recoil. Retardation is completely taken into account. The wave function is expanded in a form convenient for obtaining spin singlet and triplet solutions. As an example, the ground state of positronium is solved. (auth)

22905 ON THE ELECTROMAGNETIC MASS DIFFERENCES AMONG THE SIGMA HYPERONS. Yoshiko Sugimoto (Hiroshima Univ.). *Progr. Theoret. Phys. (Kyoto)*, 25: 189-200 (Feb. 1961).

The mass differences of the sigma triplet are discussed in terms of an electromagnetic self-energy by taking account of the virtual process $\Sigma^0 \rightarrow \Lambda^0 + \gamma \rightarrow \Sigma^0$ and the process $\Sigma^0 \rightarrow \Sigma^0 + \gamma \rightarrow \Sigma^0$ on an equal footing for the self-mass of the neutral sigma. The electromagnetic form factor is introduced to serve as a cutoff factor. With an e^2 -approximation, it can be seen that the process $\Sigma^0 \rightarrow \Lambda^0 + \gamma \rightarrow \Sigma^0$ plays an important role in the study of the mass splitting of the Σ 's. (auth)

2906 ON THE $KK\pi\pi$ INTERACTIONS. Keiji Igi (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 25: 201- (Feb. 1961).

The low energy K meson-nucleon interaction is investigated. It is assumed that K mesons are scattered via $KK\pi\pi$ interactions of both the isospin independent and dependent pions in addition to direct K meson-hyperon-nucleon interactions. In the low energy range (up to 250 Mev), S-wave nucleon scattering is assumed to be dominant. The source of S-wave K-mesons is assumed to extend to a size comparable to the potential range via the exchange of two pions. The characteristic features of low energy K-nucleon scattering are shown to be reproduced under these assumptions. The $KK\pi\pi$ interaction of the isospin dependent type is found to play an important role in K-nucleon scattering. (auth)

2907 ELECTROMAGNETIC STRUCTURE OF THE NUCLEON AND THE COMPOSITE MODEL FOR PION. Hiaki Ihara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 25: 229-34 (Feb. 1961).

The electromagnetic structure of the nucleon is investigated on the basis of the composite model for the pion. The mean square radius of charge distribution of the nucleon is calculated in the second order perturbation theory. Values of the coupling constants are found for this model, which give results consistent with the observed pion-nucleon interaction and the anomalous magnetic moment of the nucleon. The results are in qualitative agreement with experiment. It is possible to explain these phenomena consistently from the standpoint of the composite model. (auth)

2908 MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD WITH AXIAL SYMMETRY. Taro Obayashi (Nagoya Univ., [Japan]). Progr. Theoret. Phys. (Kyoto), 25: 297-9 (Feb. 1961).

The motion of a charged particle in an axially symmetric magnetic field is studied. With coordinates (r, θ, z) and the z axis as the symmetry axis, a field $\vec{H} = (H_r, 0, H_z)$ is considered. A change in coordinates and an expansion of the magnetic flux as a power series in r enables a separation near the axis, of the various motions of the particle. These motions consist of a rapid gyration around \vec{H} , a longitudinal drift along \vec{H} , and a slow drift around the axis. (T.F.H.)

2909 THE INTEGRAL STOPPING POWER OF LIQUID HYDROCARBONS FOR 5.3 MeV α -PARTICLES. Gunnar Eliasson. Trans. Roy. Inst. Technol. Stockholm, No. 178, 1-35 (1961). (In English)

The ranges of Po^{210} α particles in 22 hydrocarbon liquids are measured. The integral stopping powers relative to that of air are computed and studied by means of a phenomenological systematization. (auth)

2910 GREEN'S FUNCTION IN MAXWELL EQUATIONS FOR HETEROGENEOUS MEDIA. N. A. Khizhnyak (Inst. of Physics and Tech., Kharkov). Zhur. Tekh. Fiz., 37: 1592-1609 (1958). (In Russian)

Integral equations for describing all points of an electromagnetic field in the presence of finite or infinite dielectric bodies with arbitrary dielectric and magnetic penetrability are developed. An analysis is made of the physical aspects of integral components for points inside and outside a dielectric body. Analogous equations were derived for the two-dimensional case. These integral equations are applied to solutions of various physical problems. It is shown that an anisotropic dielectric ellipsoid and anisotropic elliptical cylinder are singular convex bodies with homogeneous intrinsic fields in an external homogeneous field. An electro-

static field exciting a uniform field in an anisotropic dielectric prism is found, and the problems on electromagnetic wave scattering on small anisotropic dielectric bodies and thin anisotropic dielectric rods are investigated. Scattering of electromagnetic waves on small anisotropic ellipsoids was analyzed as an example. (R.V.J.)

Neutron Physics

22911 (DOFL-TR-905) NEUTRON DOSIMETRY USING INELASTIC SCATTERING THRESHOLD DETECTORS. John S. Ingley (Diamond Ordnance Fuze Labs., Washington, D. C.). Mar. 16, 1961. 26p.

Employing a new threshold detector that utilizes the inelastic scattering reaction to the isomeric state of Ba^{137} , the time-integrated neutron flux above 1.9 Mev was measured in the General Atomic Triga reactor. The values compare favorably with those extrapolated from measurements of the flux above 2.9 Mev given by the standard sulfur pellet method, and evidence thus far indicates that the new method may provide a whole new series of threshold detectors. (auth)

22912 (PAN-216/IX) SOLUTION OF THE ONE-VELOCITY BOLTZMANN EQUATION WITH THE FIRST ORDER ANISOTROPIC SCATTERING OF NEUTRONS IN PLANE GEOMETRY. R. Zelazny, A. Kuszell, and J. Mika (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1961. 14p.

The Case method, developed originally for the solution of the one-velocity Boltzmann equation with isotropic scattering of neutrons, was adapted to the solution of the one-velocity Boltzmann equation with the first-order anisotropic scattering. A solution of the albedo problem for a half space is given as an illustration. (auth)

22913 (UCRL-9589) CHARGE-EXCHANGE PRODUCTION OF ANTINEUTRONS AND THEIR ANNIHILATION IN HYDROGEN (thesis). C. Keith Hinrichs (California. Univ., Berkeley. Lawrence Radiation Lab.). Mar. 14, 1961. Contract W-7405-eng-48. 83p.

A separated beam of antiprotons was sent into the 72-in. hydrogen bubble chamber. The charge exchange of antiprotons into antineutrons and the subsequent annihilation of the antineutrons were observed. The antiprotons were produced internally in the Bevatron; channeled externally by collimation, quadrupole focusing magnets, and bending magnets, and separated from other negatively charged particles by a system of three velocity spectrometers. The antiproton kinetic energy was 950 Mev. Three charge-exchange reactions were studied: (1) $\bar{p} + p \rightarrow \bar{n} + n$; (2) $\bar{p} + p \rightarrow \bar{n} + n + \pi^0$; and (3) $\bar{p} + p \rightarrow \bar{n} + p + \pi^-$. The cross section obtained for Reaction (1) plus Reaction (2) was 7.82 ± 0.55 mb. That found for Reaction (3) was 0.99 ± 0.24 mb, implying on the basis of the statistical-model alone a similar value for reaction (2). The angular differential cross section for Reaction (1) was strongly peaked forward with a value at zero degrees of 4.6 ± 0.5 mb/sr. However, the 13% contamination from Reaction (2) was included. One hundred and twenty-two of the antineutrons from Reaction (1) and (2) annihilated in the chamber, giving an annihilation cross section of 45.2 ± 5.4 mb. The average charged-pion multiplicity in antineutron annihilation was found to be 3.5 ± 0.3 , implying the total pion multiplicity was 5.2 ± 0.4 . The ratio of the number of annihilations containing five charged pions to the number containing three charged pions, and the momentum distribution of the pions, were compared with predictions of the statistical model. This

model used the covariant phase-space integrals first proposed by Srivastava and Sudarshan and modified by Neuman, and the branching ratios given by Pais. Reasonable agreement was obtained for a volume five times that of a sphere with a radius of one pion Compton wavelength. Three events were observed that fitted K^0 -meson production in antineutron annihilation. (auth)

22914 USE OF RING-SHAPED NEUTRON SOURCES IN A RESEARCH REACTOR. P. N. Cooper, K. Firth, and K. G. Stephens (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Brit. J. Appl. Phys., 12: 298-9 (June 1961).

Measurements were made of the effectiveness of ring shaped neutron sources used in the Merlin reactor. The emission rate of one neutron source was measured absolutely and the remaining sources were compared with this standard. A neutron to gamma ratio of (0.7 ± 0.1) neutron \cdot sec $^{-1}/\mu\text{c}^{-1}$ of Sb^{124} was obtained. The effectiveness of the sources was found by measuring the power generated in a sub-critical core. This result was in reasonable agreement with a calculation based on two-group diffusion theory. (auth)

22915 SLOWING DOWN FROM AN ENERGY DISTRIBUTED NEUTRON SOURCE. A. Keane (Univ. of New South Wales, Sydney). Nuclear Sci. and Eng., 10: 117-19 (June 1961).

Series expansion of the Laplace transforms occurring in slowing-down theory is shown to reproduce and extend the usual approximate solutions for an energy distributed source in an infinite nonabsorbing medium. The method also leads to a differential equation for the slowing-down density in an absorbing medium, which may be solved to any required accuracy. (auth)

22916 INVESTIGATION ON THE INELASTIC MODERATION OF FAST NEUTRONS. C. A. Heusch and T. Springer (Technische Hochschule, Munich). Nuclear Sci. and Eng., 10: 151-8 (June 1961).

The inelastic moderation of fast neutrons in heavy moderators is described by a simple model giving the mean energy loss ΔE of neutrons upon leaving a scattering system, as a function of the mean number of collisions undergone, \bar{i} . Experiments with several neutron sources (Ra-Be, D-D, D-T) are in accordance with a nearly linear dependence $\Delta E(\bar{i})$ as a suitable phenomenological description. The mean energies were determined by means of measurement of the neutron migration areas in a large moderating water volume surrounding spherical lead and bismuth scatterers. The consistency of results was checked by comparison with predictions of the evaporation model of inelastic scattering. (auth)

Nuclear Properties and Reactions

22917 (AD-251868) THE THREE-CONFIGURATION APPROXIMATION FOR BERYLLIUM TYPE ATOMS. I. V. Batarunas, V. I. Kavetskis, and A. P. Yutsis (Iutis). Translated by Valys Zilius from Trudy Akad. Nauk Litovskvi S.S.R., Ser. B, No. 3, 9-16 (1955). 9p.

The concept of two-electron states is introduced. It is shown that the transition from a one-configuration approximation to a many-configuration approximation can, for all intents and purposes, be considered a transition from the model of one-electron states to an approximation of the model of two-electron states. The three-configuration approximation is applied to the basic configuration Be , B^+ , and C^{2+} with a method by which, in the case of the investi-

gated configuration, one-electron wave functions of the self-consistent Fock field were used, and in the case of the computed configurations, analytical hydrogen-like functions. For comparison, in the cases Be and B^+ , the results of the application of such an approximation with wave functions which are solutions of simplified Fock equations for individual two-configuration approximations are given. The theoretical energy values are compared with experimental data. The possibility of developing an empirical method for deriving approximate wave functions in a multi-configuration approximation is discussed. (auth)

22918 (AFOSR-662) MAGNETIC DISPERSION CORRECTIONS TO ELASTIC ELECTRON SCATTERING. Technical Note No. 33. Abraham Goldberg (Stanford Univ., Calif. Inst. of Theoretical Physics). Mar. 1961. Contract AF49(638)-388. 31p.

The scattering of high-energy electrons by He^4 may be used as a test of quantum electrodynamics if the approximate calculation of the cross section, i.e., Born approximation, is correct. The next-order approximation in which the He^4 nucleus is virtually excited for a short time during the scattering is evaluated and found to contribute a 5% correction to the cross section, which is within the limit of experimental accuracy. (auth)

22919 (AFOSR-771) A NOTE ON REARRANGEMENT COLLISIONS. Physics Department Technical Report No. 208. T. B. Day, L. S. Rodberg, G. A. Snow, and J. Sucher (Maryland. Univ., College Park). Mar. 22, 1961. 10p. Sponsored by AEC, AF, and NSF.

The conventional Born approximation formula for rearrangement collisions is used extensively in both atomic and nuclear physics. This formula contains a direct contribution from the heavy particle or "core" interaction. A straightforward demonstration shows that for the usual case of a massive core this contribution does not appear, so that the only effect of this interaction is to distort the incident and outgoing waves. Such problems as the "post-prior" discrepancy are clarified. (auth)

22920 (BNL-672) SIGMA CENTER NEUTRON CROSS SECTION EVALUATION GROUP, NEWSLETTER NO. 4, MAY 1961. Rudolph Sher and Sophie Moore (Brookhaven National Lab., Upton, N. Y.). 7p.

Neutron total and inelastic scattering cross sections were obtained by time-of-flight techniques for Na^{23} . Results are given from 0.55 to 4.07 Mev. Measurements of the total cross section of a Pu^{239} foil in the energy range from 0.00291 to 0.1 ev were made using a crystal spectrometer. Fission cross sections in the Mev region are given for U^{238} , Pu^{239} , and Pu^{241} . Measured values of effective cross sections for fission neutrons were obtained for (n,p) reactions on Ni^{58} , Fe^{54} , Zn^{64} , Mg^{24} , Fe^{56} , Zn^{67} , and Cu^{65} . The standard notations for neutron cross sections used by the AEC Nuclear Cross Section Advisory Group are given. Resonance parameters in Th^{232} are discussed. (M.C.G.)

22921 (CEA-1913) QUELQUES ASPECTS DU PROCESSUS DE FISSION NUCLEAIRE. (Some Aspects of the Nuclear Fission Process.). Francis Netter (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1961. 64p.

Thesis submitted to Univ. of Paris.

A review is given of the present situation of the knowledge concerning the nuclear fission process, in which the nucleus goes through the saddle-point. The excitation energy of the fissioning nucleus is discussed. The measurements made at Saclay on the fast neutron fission cross section of U^{235} , U^{238} , Pu^{239} , U^{238} are described. It appears that for U^{235} there is

me characteristic shape modulation of the cross-section curve, in relation with the collective excited state of the formed nucleus at the saddle-point. Good evidence of this was also given by the study of the relative fission rate of the emission of long-range particles; it appears also that the ternary fission rate does not change substantially for neutrons between thermal energy and 2 Mev, but is lower for the compound nucleus U^{239} than for even-even compound nuclei. Some experiments on the strong 4.5 Mev gamma ray originated by slow neutron absorption in U^{235} are given. Time-of-flight devices were used to establish that this 5-Mev gamma ray seems mostly connected with radiative capture. (auth)

2922 (IS-275) STEADY-STATE NUCLEAR INDUCTION SIGNAL SHAPES IN LITHIUM METAL. David Robert Morgeson, W. H. Jones, Jr., and R. G. Barnes (Ames Lab., Ames, Iowa). Nov. 1960. Contract W-7405-eng-82. 98p. A detailed theoretical and experimental study was completed of the absorption and dispersion mode nuclear magnetic resonance signals for Li^7 in solid lithium metal at room temperature. Calculations of resonance signal shapes, based on the Bloch Theory as modified by the half-amplitude modulation theory of Halbach, were made with an IBM 650 computer and were compared with the experimental results. A variety of experimental conditions and both the in-phase and quadrature components of the signal at the modulation frequency were studied. The Bloch-Halbach Theory appears to account very satisfactorily for the saturation behavior of the four types of resonance signals. In addition, the behavior of the complex absorption mode signal provides a convenient means of determining with precision the location of the quadrature phase signal. (auth)

2923 (NAA-SR-Memo-6045) ANISOTROPIC ELASTIC SCATTERING OF NEUTRONS IN CARBON AND OXYGEN. Alter and E. R. Cohen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 20, 1961. 36p.

A distribution function for the cosine of the scattering angle in the center-of-mass system was developed. The result was applied to treating anisotropic elastic scattering of carbon and oxygen for Monte Carlo slowing down problems. The distribution function was related to the elastic scattering coefficients, which were obtained from a Legendre Polynomial expansion of the elastic scattering cross section. The energy ranges investigated were 0.330 to 10.4 Mev for carbon and 0.299 to 10.4 Mev for oxygen. (auth)

2924 (NAA-SR-Memo-6233) SIMPLIFICATION OF RESONANCE SELF SHIELDING CALCULATION. J. L. Matthews (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 27, 1961. 44p. A method of calculating self shielding L factors for use in the FORM code is discussed. L is defined as the ratio of the resonance integral for the heterogeneous lattice to the resonance integral for its corresponding homogeneous mixture. Data are presented for U^{235} and Mo from which the individual resonance L factors may be obtained by the FORM method. The simplification of using a single L factor for each element instead of the individual values for each resonance within that element was found to give the same results providing two conditions were met. The slowing down source had to be constant, and the terms of 2nd and higher order in the series expansion of the group resonance escape probability must be negligible. (auth)

2925 (ORNL-3081) EQUILIBRIUM ELECTRON DISTRIBUTIONS IN ELASTICALLY SCATTERING GASES.

R. H. Ritchie (Oak Ridge National Lab., Tenn.) and G. W. Whitesides (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 16, 1961. Contract W-7405-eng-26. 23p.

An IBM-704-7090 Fortran program was written to evaluate the equilibrium distribution function for electrons undergoing elastic collisions in a gas in the presence of a uniform electric field. The transport cross section for the scattering of electrons upon molecules of the gas is entered as a table of values and interpolation is performed by the code. Swarm averages of numerically specified quantities over the computed distribution function may be obtained. Numerical results for electrons diffusing in argon gas are given. (auth)

22926 (ORO-369) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 6, Covering Period December 1, 1960 to February 28, 1961. E. W. McDaniel, D. W. Martin, J. W. Hooper, and D. S. Harmer (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT-(40-1)-2591. 12p.

Measurements of the gross cross section for ionization of various gases by fast protons are being made. The energy of the incident particles is variable throughout the range from 0.15 to 1.1 Mev. Measurements were completed for protons incident on argon, neon, and carbon monoxide. Measurements for helium were also completed for incident proton energies below 0.85 Mev. With the exception of carbon monoxide, the experimental cross sections were found to be proportional to a power of the proton energy. A program is being set up for a computer to determine the best possible straight-line fit according to the criterion of least squares. (M.C.G.)

22927 (PAN-223/VI) ON THE IDENTIFICATION OF B^8 AND Li^8 FRAGMENTS AMONG SHORT AND STEEP HAMMERTRACKS IN ELECTRON SENSITIVE EMULSION. W. Gajewski, J. Pniewski, T. Pniewski, J. Sieminska, M. Soltan, and K. Soltynski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1961. 12p.

A method for the mean width measurements of tracks of different inclination was worked out. Determination of suitably chosen values for the correction factors made possible a direct comparison of the actual widths of tracks almost independent of their inclination. Using this method it was also found possible to identify even short and steep B^8 tracks in a heavy background of Li^8 tracks. From a sample of 120 hammertracks, four B^8 tracks were selected. (auth)

22928 (PAN-222/VII) EQUILIBRIUM DEFORMATION OF NUCLEI IN THE TRANSURANIC REGION. Zdzisław Szymański (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1961. 39p.

The equilibrium deformations and quadrupole moments of even-even deformed nuclei in the transuranic region were calculated on the basis of wave functions that take into account a pairing interaction through the superconductivity formalism. The results obtained theoretically were found to be in agreement with experiment. The relation between the potential and density deformation parameter is also discussed. (auth)

22929 (TID-12604) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 11. (Purdue Research Foundation, Lafayette, Ind.). June 15, 1961. Contract AT(11-1)-123. 54p.

Nuclear Reaction Studies. The design, operation, and calibration of a particle spectrograph are described. Measured total cross sections and interaction radii are given for the three highest-energy proton groups from (α, p) reactions with F^{19} , Na^{23} , Al^{27} , and Si^{28} . Preliminary data on the large-angle scattering of 18.6-Mev α particles by C^{12} are re-

ported. Angular Correlation and Mossbauer Effect Studies. The results of experiments done on the β - γ correlations of β transitions are reported for K^{42} , Sb^{122} , Sb^{124} , and Au^{198} . The β - γ directional correlations were measured in the decays of Ga^{72} , La^{140} , and Eu^{152} . Tables are presented for analysis of β - γ angular correlation data for first-forbidden β transitions. The transverse polarization of conversion electrons following the beta decay of Au^{198} was measured. A theoretical discussion of the influence of a combined magnetic dipole and electric quadrupole interaction on angular correlations is presented. Nuclear Spectroscopy. An activity with a half life of 1.03 ± 0.06 sec was found in the products of neutron bombardment of Mg and is probably Na^{26} produced by the $Mg^{26}(n,p)$ reaction. Studies of radiations from Si irradiated with 8-Mev He^3 ions revealed an activity with a half life of 1.35 ± 0.10 sec, which is assigned to the decay of Si^{30} produced by the reaction $Si^{28}(He^3,n)$. An activity with a half life of 3.27 ± 0.20 sec found in neutron bombardment of Si is assigned to Al^{30} . Work on the positron decay of Y^{88} is reported. Experiments on the decay of In^{110m} , Ag^{106} , and Rh^{106} are summarized. The preparation of Au-Si surface barrier charged-particle detectors is described. (D.L.C.)

22930 (TID-13053) FISSION-PRODUCT ABSORPTION IN THE INTERMEDIATE ENERGY RANGE OF 0.5-100 eV. G. Srikantiah (Brookhaven National Lab., Upton, N. Y.). Sept. 10, 1959. 21p.

An estimate of the fission-product absorption at 0.2 to 100 eV was made by obtaining the individual resonance integrals of 64 stable and near stable nuclides in 12 energy ranges. The most recent data on strength functions and level spacings were used. (J.R.D.)

22931 (TID-13189) ANGULAR DISTRIBUTIONS OF PROTONS FROM THE 19-MEV ALPHA PARTICLE BOMBARDMENT OF Na^{23} , Al^{27} , AND Si^{28} . W. D. Ploughe, E. Bleuler, and D. J. Tendam (Purdue Univ., Lafayette, Ind.). 1961. 33p.

Angular distributions were obtained for the three highest-energy proton groups from (α,p) reactions with Na^{23} , Al^{27} , and Si^{28} at 19 Mev. Reasonable fits were obtained for most of the angular distributions with the l values allowed by theory. Both the reduced total cross sections and the G factors increase for the ground-state transitions in the series F^{19} , Na^{23} , Al^{27} but decrease for the excited-state transitions, and these trends are in agreement with predictions by the shell model and knock-out mechanism. The cross sections for Si^{28} are unusually large. (D.L.C.)

22932 (UCRL-5573) TABULATED DIFFERENTIAL NEUTRON CROSS SECTIONS. PART III, VOLUME 1, 0-15 MEV. Robert J. Howerton (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 1961. Contract W-7405-Eng-48. 428p.

Part I, Volumes I, II, and III, issued as report UCRL-5226, revised October 1959. Part II, issued as report UCRL-5351, November 1958.

Tables are presented of experimental differential neutron cross sections for the elastic scattering of neutrons by nuclei in the energy range of 0 to 15 Mev. Nuclear reactions induced by neutrons are also included, particularly those that are significant for reactor-type calculations. The tables include nuclei from H to Pu. (D.L.C.)

22933 (AEC-tr-4648) TRIPLE ISOMERISM IN Ir^{194} . K. F. Alexander and H. F. Brinckmann. Translated by R. P. Metcalf (Oak Ridge National Lab.) from Z. Naturforsch., 16a: 210(1961). 3p.

After the discovery of triple isomerism in Ir^{194} , a transi-

tion energy of 90 keV and a half-life of 50 msec were reported for one of the short-lived isomers. More accurate measurements of the transition energy and half-life were carried out by the method of pulse activation with thermal neutrons. A thin target was used which contained 21 mg/cm² of iridium powder having the natural isotopic composition. The spectrum of the delayed radiation included a strong line at 67 ± 5 keV and a much weaker line at 115 ± 10 keV. Decay measurements, which were made on both lines, gave concordantly a half-life of 32 ± 2 msec. (M.C.G.)

22934 (AEC-tr-4662) (p,xn) REACTIONS INDUCED IN GOLD BY 155 MEV PROTONS. N. Poffé, G. Albouy, R. Bernas, M. Gusakow, M. Riou, and J. Teillac. Translated from J. phys. radium, 21: 343(1960). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract no. 20935.

22935 (AEC-tr-4664) ISOTOPES OF MERCURY AND GOLD WITH MASS NUMBER 190. Georgette Albouy, René Bernas, Mark Gusakow, Nina Poffé, and Jean Teillac. Translated from Compt. rend., 249: 407-9(July 20, 1959). 8p. (Includes original, 4p.).

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract no. 19620.

22936 (CEA-tr-R-544) RAYONNEMENTS RADIOACTIFS ET LEUR INTERACTION AVEC LA MATIERE. (Radioactive Radiations and Their Interactions with Matter). G. V. Gorchkov and S. A. Suppe (Soupe). Translated into French by B. De Trezvinisky from Chapter II, p.82-107 of "Radiochemical Methods of Research and Prospecting of Uranium Ores" (A publication of the State Publishing House on Geological and Technological Literature, Moscow, 1957). 47p.

The chapter is divided into sections on: passage of γ rays through matter, cosmic rays, and nuclear reactions in the earth's crust and in the atmosphere. The first is a mathematical treatment involving control of scattered γ rays, calculation of γ intensity using the effective absorption coefficient, and calculation of γ intensity for sources of different sizes and shapes. The second part discusses cosmic rays and their effects. Part three is a brief discussion of the various nuclear reactions taking place in the earth's crust and atmosphere. (T.R.H.)

22937 FURTHER GAMMA SPECTROSCOPIC INQUIRY INTO THE DECAY SCHEME OF Fe^{59} . T. Scharbert, D. Berényi, and Gy. Máthé (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 12: 305-10(1960). (In English)

The gamma rays in the decay of Fe^{59} were examined by the sum-coincidence method. The measurements definitely confirm the existence of the 1.432 MeV level and the 143 as well as the 335 keV gamma lines. It appears on the other hand that the 1.189, 1.458, and 1.479 MeV levels known from the (p, p') scattering are not involved in the decay of Fe^{59} . In the case of the 192-1097 keV cascade, the results of the preliminary angular correlation measurements differ from those reported by Schiff and Metzger. (auth)

22938 STEADY-STATE NUCLEAR POLARIZATIONS VIA ELECTRONIC TRANSITIONS. Robert H. Webb (Stanford Univ., Calif.). Am. J. Phys., 29: 428-444(July 1961).

Nuclear polarization schemes are surveyed. Special attention is given to those involving saturation of either the direct electronic transitions or the weakly forbidden electron-nucleon "cross" transitions. Rate equations are used to find the power dependence of these effects. The physical systems allowing each of these effects are considered in terms of the various types of electron-nuclear coupling. (auth)

22939 STATISTICAL MODELS IN THE STUDY OF THE REACTION $Al^{27}(d,\alpha)Mg^{25}$. G. Demortier, J. C. Odogne, and P. C. Macq (Université, Louvain, Belg.). Ann. soc. sci. Bruxelles. Ser. 1, 75: 94-101(1961). (In French)

The deenergization by α particle of Si^{28} excited by the capture of deuterons in Al^{27} was studied. The following values were derived: $T = 1.7$ Mev, $\tau = 2$ Mev, $t = 1.8$ Mev, $E = 5.3$ Mev $^{-1}$. Further tests are being made in order to support these conclusions. (P.C.H.)

22940 ELASTIC DIFFUSION OF 14 MEV NEUTRONS AT SMALL ANGLES. G. Deconninck, A. Martegani, J. P. Eulders, and J. Stoguart. Ann. soc. sci. Bruxelles. Ser. 1, 75: 102-5(1961). (In French)

Small angle elastic scattering cross sections are measured at 14 Mev for 4 groups of elements (Fe, Zn, Cu), Cd, Sn), (Pb, Bi), and U^{238} . Three effects may be responsible of an increase of the cross section in forward direction: magnetic coupling, polarizability, and atomic electron collisions. The results show an unexpected behavior for Fe, Zn, and Cu. (auth)

22941 WAVELENGTHS OF KRYPTON 86, MERCURY 198, AND CADMIUM 114. C. F. Bruce and R. M. Hill (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales). Australian J. Phys., 14: No. 1, 64-88(Mar. 1961).

The vacuum wavelengths and spectral line profiles of four lines of Kr^{86} , four lines of Hg^{198} , and four lines of Cd^{114} are measured. One line, the radiation $2p_{1/2}-5d_{5/2}$ of Kr^{86} (6057 Å) is used as the reference standard in the wavelength measurements. A variable gap Fabry-Perot interferometer is used under vacuum conditions. Photoelectric recording methods and mechanical scanning make possible comparison of wavelengths with an accuracy of better than 1 part in 10^6 . Half-intensity widths of lines are measured with an accuracy of 0.05 m $^{-1}$. The 6057 Å line of Kr^{86} is examined under different operating conditions of the lamp. Small wavelength shifts due to variation of temperature, pressure, and current density are measured. The Doppler shift and interatomic Stark shift annul each other if the lamp is viewed in the direction cathode to anode to observer, and is operated in a liquid air bath with the temperature near the capillary surface of the lamp at $63 \pm 1^\circ K$ and with a current density of 0.28 ± 0.05 amp/cm 2 . The Doppler shift under these conditions is found to be $+0.014 \pm 0.003$ m $^{-1}$ and the interatomic Stark shift -0.014 ± 0.003 m $^{-1}$. Under these conditions also the half-intensity width is 1.35 ± 0.05 m $^{-1}$, and the wavelength emitted is that for the unperturbed state of the atoms to 2 or 3 parts in 10^6 . This line is superior to the other lines examined for sharpness and reproducibility and other wavelengths may be established in terms of it to at least 1 part in 10^6 . This line is recommended as the new primary standard of length. (auth)

22942 ENERGY LEVELS IN ^{15}N . V. R. McKenna, A. M. Baxter, and G. G. Shute (Univ. of Melbourne). Australian J. Phys., 14: 196-9(Mar. 1961).

Energy levels of excited states of N^{15} are found from a study of the differential cross sections ($d\sigma/d\Omega$) for elastic scattering of protons on C^{12} . Proton energies of 5 to 11.5 Mev are used, and $d\sigma/d\Omega$ is measured at c.m. angles of 25 to 170° . Energy levels in N^{15} between 8 and 12 Mev are inferred. (T.F.H.)

22943 ROLE OF EXCHANGE ENERGY IN INTERMEDIATE-RANGE INTERACTIONS. Frank O. Ellison (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Phys., 34: 2100-4(June 1961).

Computations were made of the Coulomb and exchange parts of the interaction energies of a proton with one and two hydrogen atoms. It was found that the exchange energy becomes a more important and Coulomb energy a less important fraction of the first-order interactions as the internuclear distance is increased. It is shown that the first-order contribution is necessary to bring the perturbation calculations of Coulson on H_2^+ and of Löwdin and Hirschfelder on H_2 into good agreement with experiment for intermediate separations. (auth)

22944 ON THE VALIDITY OF THE STATIC APPROXIMATION FOR THE EVALUATION OF THE TWO-NUCLEON POTENTIAL. Malcolm C. Younger and Abraham Klein (Univ. of Pennsylvania, Philadelphia). J. Franklin Inst., 271: 458-70(June 1961).

The perturbative two-pion exchange nuclear potential is computed in an approximation that does not neglect the possible large recoil of the nucleon upon emission or absorption of a virtual pion. Upon the assumption that initial and final momenta are nonrelativistic, the result is a local potential, to which completely static approximations bear a qualitative resemblance. Correction terms of order (μ/Mx) are found, where μ and M are the pion and nucleon masses respectively, and x is the nucleon separation in units of the pion Compton wavelength. (auth)

22945 THE USE OF CsI (Tl) CRYSTAL FOR THE DETERMINATION OF ABSOLUTE GAMMA EMISSION RATES. P. K. Srivastava and U. C. Gupta (Atomic Energy Establishment, Trombay, India). J. Sci. Ind. Research (India), B, 20: 243-6(1961).

A single-channel scintillation spectrometer with a CsI (Tl) crystal detector is used for the determination of absolute gamma emission rates of some radionuclides. The absolute efficiency of the CsI cylindrical detector (1 in. thick and 1.5 in. diam) is calculated for gamma energies from 0.1 to 5 Mev for point sources situated on the axis of the detector. The peak-to-total ratio for the detector is also measured. (auth)

22946 HALF LIVES OF FIRST EXCITED STATES OF EVEN NUCLEI OF Em, Ra, Th, U, AND Pu. R. E. Bell, S. Björnholm, and J. C. Severiens (Univ. of Copenhagen, McGill Univ., Montreal, and U. S. Atomic Energy Commission, Washington, D. C.). Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd., 32: No. 12, 1-48(1960). (In English)

The half lives of the first excited states of eighteen even nuclei of Rn, Ra, Th, U, and Pu are measured, and an upper limit is set for a nineteenth. The measurements are made by the delayed coincidence method, using a fast time-to-amplitude converter. The experimental half lives all lie between 1.5 and 7.6×10^{-10} sec. The results are used to calculate reduced transition probabilities, quadrupole moments, and deformation parameters for the nuclei concerned. Comparisons are made between these values and theoretical calculations. Agreement within 10% or less is found. Upper limits are set for the half lives of two excited states in Th^{230} and U^{233} , and calculated E2 conversion coefficients are verified within about 15% for this region of Z and energy. (auth)

22947 INELASTIC SCATTERING OF NEUTRONS BY U^{238} BELOW 1 MEV. Lawrence Dresner (Institut für Neutronenphysik und Reaktortechnik, Kernforschungszentrum, Karlsruhe, Ger.). Nuclear Sci. and Eng., 10: 142-50(June 1961).

The neutron excitation cross sections for the individual energy levels of U^{238} below 1 Mev have been calculated for neutron energies up to 1 Mev with the statistical theory of Hauser and Feshbach. (auth)

22948 DOPPLER BROADENING OF LOW-ENERGY NEUTRON RESONANCES. A. W. Solbrig, Jr., (Argonne National Lab., Idaho Falls, Idaho). Nuclear Sci. and Eng., 10: 167-8(June 1961).

A derivation of a well known exact equation for the shape of a Doppler-broadened neutron absorption resonance is discussed very briefly. Approximate forms of the equation are developed. (auth)

22949 LOW-ENERGY NEUTRON RESONANCES IN Eu^{151} . S. Tassan, A. Hellsten, and V. L. Sailor (Brookhaven National Lab., Upton, N. Y.). Nuclear Sci. and Eng., 10: 169-72(June 1961). (BNL-5064)

The total neutron cross section of Eu^{151} was measured in the energy range from 0.10 to 1.00 eV, using samples of high isotopic purity. The parameters for the double resonance, which occurs at 0.321 and 0.460 eV, were derived by fitting the data to the sum of two single-level Breit-Wigner expressions. (auth)

22950 INTERFERENCE IN THE RADIATIVE CAPTURE OF NEUTRONS. R. E. Coté and L. M. Bollinger (Argonne National Lab., Ill.). Phys. Rev. Letters, 6: 695-7(June 15, 1961).

The aim of the experiment was to measure the relative intensity of individual capture gamma rays as a function of neutron energy in the vicinity of Pt^{195} resonances at 11.9 and 19.6 eV. It was concluded that interference does occur between radiative transitions associated with neutron resonances of the same J. The argument is strengthened by the fact that the maximum between the resonances and the minimum above are accounted for by consideration of only the well known nearby resonances and are not strongly dependent on the parameters of the less well known distant resonances. (P.C.H.)

22951 COMPOUND NUCLEUS PROCESSES IN THE REACTIONS BETWEEN COMPLEX NUCLEI. Tetsuo Kammuri (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 25: 235-46 (Feb. 1961).

A modification is made in the statistical theory of nuclear reactions to take account of the angular momenta of the relevant nuclear states in reactions. Since the average values of the angular momenta of the compound nuclei formed by different projectiles at the same excitation energy will be different, various aspects of decay processes also depend on the incident particles. The spin dependence of the nuclear level density must be taken not as $(2I+1)$, but as $(2I+1) \exp[-(I+1)/2\sigma T]$. The energy spectra of emitted particles are treated. The average kinetic energy of evaporating neutrons from a high spin nucleus becomes higher than twice the nuclear temperature T . It is shown that the anomalies found in the branching ratios or excitation functions in the heavy ion reactions can be explained by the angular momentum effect. The degree of these anomalies depends sensitively on the nuclear moment of inertia χ^2 . (auth)

22952 ON THE CHARGE EXCHANGE COLLISION IN NUCLEON-DEUTERON. Yoshiyuki Sakamoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 25: 259-76(Feb. 1961).

The nucleon-deuteron charge exchange collision is investigated using the two-nucleon scattering phase shifts, in order to supplement information regarding the two-nucleon interaction in a singlet isotopic spin state, and also to study a source for the partially polarized neutron beam. This type of beam may be used to investigate the interaction between the neutron and a given nucleus. The differential cross section, polarization, and triple scattering parameters of the nucleon ejected in the charge ex-

change nucleon-deuteron collision are calculated. The energy distribution of the ejected nucleons is calculated by means of the magnetic dipole deuteron photodisintegration cross section rather than by the explicit use of the wave functions of the di-neutron (or di-proton) and the deuteron to evaluate the nuclear matrix element. The polarization and triple scattering parameter of the nucleon quasi-elastically ejected from the nucleus, such as C^{12} , in the charge exchange collision and of the nucleon caused by the free $n(p,n)p$ and $p(n,p)n$ processes are calculated for comparison. (auth)

22953 NEW ANALYSES OF ANOMALOUS IMAGINARY PART. Jun Otokozawa (Tokyo Univ.). Progr. Theoret. Phys., 25: 277-89(Feb. 1961).

Using a method of analytic continuation and parameter integration, the anomalous imaginary part of the scattering amplitude is written explicitly with the absorptive part of the matrix element that connects the initial or final state with the intermediate state. The meaning of the intermediate state is clarified. In the case of pion-deuteron scattering, all the singularities are determined. These singularities agree with those obtained by performing a direct parameter integration on the fourth order diagram. (auth)

22954 NON-ADIABATIC EFFECTS ON THE BOUND STATES OF THE μ -MESONIC PROTON-DEUTERON SYSTEM. Hajime Narumi (Doshisha Univ., [Japan]) and Shigeru Matsuo. Progr. Theoret. Phys. (Kyoto), 25: 290-2(Feb. 1961).

A perturbation method is used to find the vibrational and rotational energy levels of the bound states in the $p\text{-d-}\mu$ -system at liquid H temperatures. The calculations are carried out to order $M^{-\frac{1}{2}}$, where M is the $p+d$ mass. The energy levels for $J=0, 1, 2$ and $v=0, 1$ are determined. (T.F.H.)

22955 EXCITED STATE IN $\lambda\text{-}\pi$ SYSTEM AND K^-p COLLISION. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 25: 292-4(Feb. 1961).

The effects of the 1.38-Bev $\pi\text{-}\Lambda$ resonance (Λ^*) are studied in low energy K^-p reactions. The K^-p reaction cross sections $\sigma(K^-p)$ at these energies are much larger than the $\sigma(K^+p)$ values. It is shown, from a comparison of the calculated and observed relative Σ and Λ production amplitudes, that the large values of $\sigma(K^-p)$ cannot be ascribed to the Λ^* . The effects of the existence of a $\pi\text{-}\Sigma$ resonance (Σ^*) on this conclusion are studied. Use of the reaction $p + \pi^- \rightarrow \Lambda^0 + \pi^- + K^+$ to verify the Λ^* is suggested. (T.F.H.)

22956 THE EFFECT OF PION-PION INTERACTION TO THE PION-NUCLEON SMALL P-WAVE PHASE SHIFTS. Kin-ichi Ishida (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 25: 294-6(Feb. 1961).

The pion-nucleon ($\pi\text{-}N$) interaction is studied by dispersion theoretic means. It is shown that S- and P-wave $\pi\text{-}\pi$ interaction contributions may be used to explain the small P-wave $\pi\text{-}N$ phase shifts. (T.F.H.)

22957 VERY HIGH ENERGY NUCLEAR REACTIONS AND ALPHA-PARTICLE MODEL. Hiroichi Hasegawa (Gakushuin Univ., Tokyo) and Kensai Ito. Progr. Theoret. Phys. (Kyoto), 25: 300-1(Feb. 1961).

Collisions of cosmic $4n$ nuclei C and O with emulsion nuclei are studied at 2 to 3 BeV/nucleon. From geometrical considerations, the probabilities for stripping 0, 1, 2, or 3 α particles from the incident nucleus are calculated. The observed percentages are compared with the probabilities. It is concluded that the α particle model of $4n$ nuclei is valid in the energy range considered. (T.F.H.)

2958 ON THE G_A/G_V RATIO IN β -DECAY. II. Chiaki Nara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 25: 301-3 (Feb. 1961).

The ratio (G_A/G_V) of observed and bare axial vector coupling constants in β decay is calculated, taking into consideration second and higher order processes. The effects of variations in momentum integral cutoffs are shown. (G_A/G_V) is tabulated in the (s, t, p) and (v, a) cases. (T.F.H.)

2959 RADIOACTIVATION BY THE (γ, γ) -REACTION. III. ACTIVATION CROSS-SECTION OF ^{103}Rh FOR $^{103}\text{Rh}(\gamma, \gamma)^{103\text{m}}\text{Rh}$ REACTION. Nagao Ikeda and Kenji Yoshihara (Tokyo Univ. of Education and Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 8: 24-7 (Mar. 1959). (In Japanese)

The activation cross section for $\text{Rh}^{103}(\gamma, \gamma)\text{Rh}^{103\text{m}}$, using 10-ke cobalt-60 source, was investigated. Samples of rhodium uniformly electrodeposited on silver plates were subjected to gamma-irradiation for 40 hours. The radioactivities produced were then measured with a proportional counter. The observed half life was 57 min, corresponding to that of $\text{Rh}^{103\text{m}}$. A value of $3 \times 10^{-32} \text{ cm}^2$ was obtained for the activation cross section. (N.W.R.)

2960 FUNDAMENTAL STUDIES ON SECONDARY RADIATIONS EMITTED FROM VARIOUS TARGETS BY P-BETA BOMBARDMENT. Yoshio Onai, Teizo Tomaru, and Ryuji Mori (Hospital of Cancer Inst., Tokyo). Radioisotopes (Tokyo), 9: 96-101 (Sept. 1960). (In Japanese)

The quantity and quality of secondary radiations from Pb, Cu, Al, and plastic targets bombarded by P^{32} beta particles were investigated with a G-M counter and a scintillation detector. From the absorption curves of secondary radiations, the practical maximum range of secondary electrons was about 150 mg/cm^2 . For Pb, fluorescent radiations were observed with a scintillation detector. For targets much thinner than the maximum range of P^{32} beta rays, the intensity of bremsstrahlung increased with increasing atomic number of the target materials. On shielding the radiations emitted from various targets with thick lead, the differences in quality became small and the quantity increased with increasing atomic number of the targets. For targets much thicker than the maximum range of B rays, the quantity decreased with increasing atomic number. For reflection targets, the quantity increased with increasing atomic number of the targets. (P.C.H.)

2961 CROSS-SECTIONS FOR THE (n, 2n) REACTIONS $\text{Th}^{232}\text{U}^{238}\text{U}^{235}$ AND ^{238}Np WITH 14 MeV NEUTRONS. J. L. Verkin and R. F. Coleman (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Reactor Sci. and Technol., J. Nuclear Energy, Pts. A and B, 14: 69-75 (May 1961).

Cross sections for the reactions $\text{Th}^{232}(n, 2n)\text{Th}^{231}$, $\text{U}^{238}(n, 2n)\text{U}^{237}$, and $\text{Np}^{237}(n, 2n)\text{Np}^{236}$ with 14-Mev neutrons were found by activation methods. Th^{231} and U^{237} were detected by observing their γ rays with a sodium iodide scintillation spectrometer. Np^{236} was estimated by counting the α -particle activity of its daughter Pu^{238} . The cross sections found were as follows:

| Target nuclide | (n, 2n) cross section (barns) | Neutron energy (Mev) |
|-------------------|-------------------------------|-----------------------|
| Th^{232} | 1.20 ± 0.05 | 14.1 ± 0.3 |
| U^{238} | 0.69 ± 0.04 | 14.5 ± 0.4 |
| Np^{237} | 0.39 ± 0.07 | 14.5 ± 0.4 (auth) |

2962 MEASUREMENTS OF THE ENERGY DEPENDENCE OF THE CROSS-SECTION OF THE $\text{Cl}(n, \gamma)$ REACTION. T. Kashukev, Yu. P. Popov, and E. L. Shapiro (Lebedev

Physical Inst. of the Academy of Sciences, U.S.S.R., Moscow). Reactor Sci. and Technol., J. Nuclear Energy, Pts. A and B, 14: 76-84 (May 1961).

The energy dependence of the cross section for the reaction (n, γ) in natural chlorine in the energy range from several ev to ~ 20 kev was measured with the aid of a slowing-down-time neutron spectrometer employing lead. For the energy of the negative level of chlorine the value $E_0 = -210 \pm 10$ ev was obtained. The parameters of the 405 ev level were determined $\sigma_0 \Gamma_\gamma = 90 \pm 8$ Bev, $g \Gamma_n = (2.4 \pm 4.0) \times 10^{-2}$ ev depending on the assumed compound nucleus spin. A resonance was noted in the measurements at $E_0 = 4.3 \pm 0.5$ kev with the strength $\sigma_0 \Gamma_\gamma = 60 \pm 20$ Bev. (auth)

2963 THE ENERGY DEPENDENCE OF THE FISSION CROSS-SECTIONS OF ^{238}U , ^{235}U AND ^{239}Pu FOR NEUTRONS IN THE ENERGY RANGE 12.6 TO 20 MeV. B. Adams, R. Batchelor, and T. S. Green (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Reactor Sci. and Technol., J. Nuclear Energy, Pts. A and B, 14: 85-90 (May 1961).

Measurements of the variations of the fission cross sections of U^{238} , U^{235} , and Pu^{239} were made in the energy region 12.6 to 20 Mev. Relative measurements on U^{238} were made using a multiplate fission counter and these were normalized to a known value at 14 Mev. Ratio measurements were then used to obtain the cross sections of U^{235} and Pu^{239} . (auth)

2964 ON VIBRATIONAL LEVELS IN EVEN-EVEN NUCLEI. Lennart Simons (Univ. of Helsinki). Soc. Sci. Fennica, Commentationes Phy.-Math., 25(7): 13p. (1961). (In English)

A rather complete knowledge has been acquired of 2+ levels in heavy and medium weight even-even nuclei that can be two phonon ($K = 2$) γ -vibrational levels. Except for nuclei with nearly closed shell structure, this level is found among the lowest excited levels. A very prominent rise in the energy of this level is found when N and Z approach magic numbers and certain other numbers, too. This justifies the assumption that the energy can be expressed in the form $E = \frac{F(N, Z)}{(N-N_1)(N-N_2) \dots (Z-Z_1)(Z-Z_2) \dots}$, where N_1 and Z_1 are magic or half-magic numbers, $F(N, Z)$ is a smooth function of the neutron number N and the proton number Z. This actually turns out to be the case in every range limited by such N_1 and Z_1 values. Generally $F(N, Z)$ is a linear function of N and Z. In certain cases F is almost constant. Based on known experimental values of confirmed vibrational levels in certain nuclei such formulas can be used to deduce E values for nuclei with N and Z values close to the initial values. It is concluded that the levels at 1182, 1400, 1740, 1500, and 1100 kev in respectively Gd^{158} , Gd^{164} , Gd^{162} , Sm^{152} , and Hg^{200} should be γ -vibrational levels with 2+ and $K = 2$. (auth)

2965 SLABYE VZAIMODEISTVIYA NOVEISHIE IS-SLEDOVANIYA β -RASPADA. (Weak Interactions. New Data on β Decay). A. I. Alikhanov. Moscow, Publishing House of Literature of Physics and Mathematics, 1960. 143p.

Current data on β decay and the non-conservation of parity in weak interactions are reviewed. Electron emission asymmetry in oriented-nucleus β decay, longitudinal β -electron polarization, temporary parity, experimental determinations of β -interaction constants, and antineutron capture by protons are discussed. (R.V.J.)

2966 ELECTROMAGNETIC STRUCTURE OF NUCLEONS. S. D. Drell and F. Zachariasen. Oxford Library of the Physical Sciences. London, Oxford University Press, 1961. 117p.

The charge and moment form factors of nucleons are studied. The theoretical difficulties involved in finding the form factors from experimental data on such processes as $e-p$, $e-n$, and $e-d$ elastic scattering; $e-d$ inelastic scattering; and reactions $e+p \rightarrow e+p+\pi^0$ and $e+p \rightarrow e+n+\pi^+$ are studied. Dispersion and perturbation theoretical approaches to the calculation of the form factors are considered. A treatment of the problem in meson theory is given, including the effects of the pion form factor and two pion exchange. It is noted that a quantum electrodynamic formulation of the nucleon form factors enables a more complete interpretation of experimental data than other types of approaches. (T.F.H.)

22967 NUCLEAR SIZES. L. R. B. Elton. Oxford Library of the Physical Sciences. London and New York, Oxford University Press, 1961. 117p. 15s. and \$2.40.

A consistent picture of the atomic nucleus is presented from experimental data which gives information on the sizes of the nucleus and the distribution of nuclear matter. The information is presented systematically and interpreted in terms of certain parameters, such as nuclear radius, thickness of nuclear surface, and densities. The evidence is analyzed by electron scattering, electrostatic energy shifts, scattering of nuclear particles, and total energy of nuclei. (N.W.R.)

Particle Accelerators

22968 (AFCRL-TN-60-822) RESEARCH DIRECTED TOWARD THE DEVELOPMENT OF A PULSED AIR-CORE BETATRON. Scientific Report. William G. Guindon (Boston, Coll., Chestnut Hill, Mass.). Sept. 19, 1960. 47p. (AD-248588)

The equations of motion of an electron in a cylindrically symmetric changing magnetic field are analyzed with a view to displaying the conditions for betatron acceleration and focusing of a betatron beam. Details are given of a 36-kilojoule capacitor bank and related switching apparatus which were designed primarily for powering a pulsed air-core betatron. A series of models of betatron coil configurations is described, together with the method and results of measuring their magnetic field distributions. Full-scale tests of a model that appeared likely to satisfy the conditions for betatron operation proved successful. In a discussion of the results of these tests, suggestions are given for further theoretical analysis and for experimental refinements of the apparatus. (auth)

22969 (BNL-5529) ABSOLUTE BEAM CURRENT MEASUREMENTS IN THE AGS. E. C. Raka (Brookhaven National Lab., Upton, N. Y.). Apr. 24, 1961. 4p.

Two methods used for measuring the injected and accelerated proton current in the Brookhaven Alternating-Gradient Synchrotron are discussed. Current transformers are used on the linac beam transport system, while electrostatic induction cathodes are used on the AGS ring. The current transformers are used to monitor the injected current only, while the induction electrodes are used to monitor both the injected and the accelerated beam. Methods of calibrating these measuring systems and the possible sources of error in each measurement are discussed. (M.C.G.)

22970 (BNL-5530) INJECTOR TYPE: PHASE-SPACE MATCHING, AND SPACE-CHARGE CONSIDERATIONS FOR A 1000 BEV AGS. Lee C. Teng (Brookhaven National Lab., Upton, N. Y.). Mar. 24, 1961. Contract [AT-(30-2)-GEN-16]. 11p.

Three types of 10-Bev injectors for a 1000-Bev Alternating-Gradient Synchrotron, a synchrotron, an FFAG ring, and a Linac were studied with regard to the following considerations: matching of transverse oscillations and extraction efficiency, matching of longitudinal oscillations, matching of space-charge limits and filling efficiency, and ease of construction and economy. A merit score was given for each of these items. Results indicated that the Linac would be the best injector for the 1000-Bev AGS. (M.C.G.)

22971 (BNL-5531) PHASE-SPACE MATCHING OF LONGITUDINAL (PHASE) OSCILLATIONS USING THE INJECTOR AS THE MATCHING SYSTEM. Lee C. Teng (Brookhaven National Lab., Upton, N. Y.). Apr. 10, 1961. 11p.

There are two fixed points in one cycle of the phase space of the phase oscillation in either a Linac or a circular accelerator (Cirac): one stable and the other unstable. By introducing phase jumps in the rf it was found to be possible to put the phase-space ellipse of the phase-points of the particles at either one of these fixed points for any desired length of time and in any desired sequence. Numerical examples are given. The example is worked out for the phase oscillation matching scheme from a drift-tube Linac pre-injector which accepts an 800-keV beam from a Cockcroft-Walton machine, and gets its rf phase-space buckets filled, and injects into a traveling-wave Linac injector at 200-MeV which in turn injects into a 1000-Bev AGS at 10 BeV. Linear and adiabatic approximations were used. (M.C.G.)

22972 (BNL-5532) MINUTES OF THE LINEAR ACCELERATOR CONFERENCE HELD AT BROOKHAVEN NATIONAL LABORATORY DURING APRIL 1961. A. van Steenberg, comp. (Brookhaven National Lab., Upton, N. Y.). 109p.

A conference was held for discussing the design of linear accelerators suitable for use as injectors for high-energy machines. Drift-tube shaping and linac phase oscillations were treated in some detail. It is concluded that a 2- to 10-Bev linac delivering ~20-mA protons can be designed from the available information for a 300- to 1000-Bev synchrotron but that the 150- to 400-MeV section of the linac will be inefficient. (D.L.C.)

22973 (CERN-61-9) LE SYNCHROTRON A PROTONS DU CERN. (3eme partie). (The CERN Proton Synchrotron (Part 3)). E. Regenstreif (European Organization for Nuclear Research, Geneva. Proton Synchrotron Group). Mar. 6, 1961. 250p.

The comprehensive treatment of the CERN Proton Synchrotron installation continues with chapters on Magnet Supply, Vacuum, Controls, and Geodesy Problems. (T.R.H.)

22974 (INS-TH-16) STRONG-FOCUSING ELECTRON-SYNCHROTRON BETATRON OSCILLATION ANALYSIS. Yoshiyuki Kobayashi and Hiroshi Sasaki (Tokyo Univ. Inst. for Nuclear Study). Sept. 10, 1957. 36p.

A discussion is given of the treatments developed by the Cambridge Design Study Group and G. Luders, somewhat modified for the convenience of the design of the INS electron synchrotron. The analysis is presented in terms of the matrix representation of betatron oscillations, the stability conditions of betatron oscillations, betatron oscillation amplitudes, and the influence of errors. Conclusions are given for the choice of the unit and the operation point. (B.O.G.)

22975 (INSJ-39) THE RF DRIVING SYSTEM OF THE HIGH POWER PULSED KLYSTRON FOR THE 6 MeV LINEAR ELECTRON ACCELERATOR. Kazuhiro Ishii,

ra Miyahara, and Tetsuji Nishikawa (Tokyo Univ. Inst. Nuclear Study). Apr. 21, 1961. 15p. (TH-40)
The RF driving system of a 6-Mev electron linear accelerator used as the injector of a 1-Bev electron synchrotron is described. The frequency stability of the RF system is determined by the traveling wave tube (TWT) oscillator. Design of the TWT oscillator having an external feed-back loop with a standard resonant cavity and phase shifter is described. (J.R.D.)

776 (TID-6597(Rev.)) VISIT OF U. S. HIGH-ENERGY PHYSICS TEAM TO U.S.S.R., MAY 1960. George A. Kolstad and E. J. Lofgren (Atomic Energy Commission, Washington, D. C.). 58p.

The accelerators, instrumentation, and laboratories seen during the visit of the U. S. High-Energy Physics Team to the USSR in May 1960 are described. The itinerary of the trip and the people that the team talked to are discussed. (C.G.)

777 (TID-12588) LINEAR ELECTRON ACCELERATOR STUDIES AND PROPOSED TWO-MILE ACCELERATOR PROJECT. Combined Status Report, January 1 to March 31, 1961. (Stanford Univ., Calif. W. W. Hansen, Dept. of Physics). Apr. 1961. Contracts AT(04-3)-21 and AT(04-3)-363. 54p. (ML-803; M-260)

Activities are discussed for studies conducted on the anomalies and properties of the Mark-III and Mark-IV linear electron accelerators, and the design and development of the proposed two-mile accelerator. (B.O.G.)

778 (TID-13076) TRANSIENT BEAM LOADING CALCULATIONS FOR LINEAR ELECTRON ACCELERATORS. PART I. UNIFORM STRUCTURES; PHASE MODULATION. R. H. Helm (Stanford Univ., Calif.). May 1961. 26p. (M-266)

A summary is presented of results on calculations of the transient beam loading in axially uniform linear electron accelerators. The effects of transient phase modulations of the rf field and in the beam current are included. Formulas and numerical results are given for several special examples. (auth)

779 (UCRL-9546) BEVATRON OPERATION AND DEVELOPMENT. XXVII AUGUST, SEPTEMBER, OCTOBER 1960. Walter D. Hartough and Glen R. Lamberton (University of California, Berkeley. Lawrence Radiation Lab.). Apr. 2, 1961. Contract W-7405-eng-48. 25p.

Bevatron operation averaged 77% of the scheduled operating time this quarter. The machine was off 21% of the scheduled operating time due to equipment failure and 2% at the request of the user. The physics research program which was devoted to study of K^- - and π^- -meson interactions in hydrogen and deuterium. Seven chemistry bombardments were made in the internal proton beam. (auth)

780 (USNRDL-TR-508) PRECISION VOLTAGE REFERENCE SUPPLY. W. E. Smith (Naval Radiological Defense Lab., San Francisco). May 9, 1961. 18p.
In the operation of the model magnet for cyclotron design the need arises for an ultra stable voltage reference supply. It is necessary that the supply be capable of delivering 1.2 to 1.4 milliamperes to a 1100-ohm load. The voltage reference should be stable to 0.005% over a day's time, operating essentially at room temperature with a maximum variation of 5°C. A device was constructed that used two voltage reference tubes and three zener diodes to maintain this regulation. The voltage supply was placed in an environment in which it was to be used and was monitored over a month. The standard deviation of the voltage measurements made was 0.0017% with the maximum deviation observed being 0.0023%. (auth)

22981 (CEA-tr-X-240) PROJET DU CYCLOTRON DE 16 MeV. (16-Mev Cyclotron Project). Translated into French. V. Lopasich, T. Bosanats, and M. Konrad (Institut "Rudjer Bošković," Zagreb). [nd.] 16p.

The electromagnet, its base, and its coils are described for a 16-Mev cyclotron project in Yugoslavia. After outlining the requirements in materials, dimensions, and design for the magnet, the dimensions of the base are discussed. (T.R.H.)

22982 (NP-tr-627) CAPACITANCE GENERATORS AND THEIR APPLICATION AS HIGH VOLTAGE SOURCES OF ION ACCELERATORS. Karel Malek. Translated from *Elektrotech. obzor.*, 45: No. 3, 138-44(1959). 18p.

An analysis was made of the operating principles of variable capacitance generators and their application as high-voltage sources in ion accelerators. A small capacitance generator was constructed on the principle of cascade connections and the characteristics of the generator were measured. (B.O.G.)

22983 (NP-tr-643) PROBLEMS AND TECHNIQUES IN EXPERIMENTS (SELECTED ARTICLES). Translated from *Pribory i Tekh. Ekspt.*, No. 2, 146-8; 150-2(1960). 15p.

Two articles are presented concerning the measurement of ion currents in ion-accelerating systems, and the structure of a 50-kv ion-accelerating tube. Separate abstracts were prepared for each of the papers. (B.O.G.)

22984 A 2-MEV MICROTRON. Éva Kisdi-Koszó and L. Turi (Central Research Institute of Physics, Budapest). *Acta Phys. Acad. Sci. Hung.*, 12: 273-8(1960). (In English)

The 2 Mev microtron having 8 orbits, designed, built, and put into operation is described. Mean current intensities of 5×10^{-9} amp with peaks of 10^{-5} amp are obtained on the last orbits, 50% of which can be brought from the accelerator into the laboratory. (auth)

22985 THE APPLICATION OF THE CYCLOTRON FOR THE PREPARATION OF RADIONUCLIDES. W. Sellmann-Eggebert (Institut für Radiochemie, Kernforschungszentrum, Karlsruhe, Ger.). *Atomwirtschaft*, 6: 273-7(May 1961). (In German)

Cyclotrons produce charged particles with sufficiently high kinetic energies to bring about nuclear transformations in even the heaviest nuclei. The formation of given end products can be influenced by the choice of bombarding particle and its energy. Reaction mechanisms, yields, and chemical reprocessing as well as problems of target irradiation are described with reference to the Karlsruhe cyclotron. (auth)

22986 PROJECTS FOR NEW ACCELERATING MACHINES. PART I. Edouard Regenstreif (CERN, Geneva). *Inds. atomiques*, 5: No. 3-4, 61-70(1961). (In French)

A review is given of new projects in accelerators. These include both new constructions and modifications of existing accelerators. Some physical or engineering factors which impose limitations on the performance of conventional accelerators are reviewed briefly, and the tendency to high energies and high intensities is discussed. Projects to increase the energy in existing accelerators are summarized, and projects to increase the intensity are reviewed. (J.S.R.)

22987 RADIATION MEASURED NEAR A BETATRON DURING THE EMISSION OF HIGH ENERGY ELECTRONS. I. STUDY ON THE NATURE AND DISTRIBUTION OF THE RADIATION IN THE IMMEDIATE VICINITY OF THE APPARATUS. P. G. Paleani Vettori and F. Pigorini (Università, Rome). *Nuntius Radiol.*, 27: 21-36(Jan. 1961). (In Italian)

The results Ionimetric measurements made in proximity to 15-Mev SRW Betatron of the Radiological Institute during the emission of beams of high energy electrons are reported. By disposing the ionization chambers in contact with the calotte of the apparatus, the presence of considerable quantities of radiation along the whole perimeter of the apparatus could be observed; at a point of the upper part of the calotte the measured ionizations reached particularly high values up to 36 r per 100 rad of the primary beam, and the emitted radiations followed a direction almost opposite to that of the primary beam. Investigations were also performed in order to analyze the nature and the energy of the radiations emitted in various points. The hypothesis is advanced that the phenomena observed are connected with those electrons, which, after having been accelerated, do not go out of the doughnut window but are dispersed in the walls of the doughnut itself. (auth)

22988 FORMATION OF HELIUM ION BEAMS BY THE INJECTION OF A NEUTRAL HELIUM BEAM INTO A TANDEM ACCELERATOR. P. H. Rose, A. B. Wittkower, R. P. Bastide, and A. J. Gale (High Voltage Engineering Corp., Burlington, Mass.). *Rev. Sci. Instr.*, 32: 568-71 (May 1961).

A neutral helium beam, obtained by charge-exchange of fast He^+ in helium gas, was injected into a tandem accelerator. The energetic neutral beam drifted to the central terminal where electron stripping occurred in oxygen gas, and the resulting He^+ and He^{++} ions were accelerated from the terminal to ground. These ions were then separated by a 90° analyzing magnet. Approximately $1.6 \mu\text{A}$ He^+ and $1.0 \mu\text{A}$ He^{++} were obtained at an injection energy of 450 keV independent of the tandem terminal voltage. Beam intensities were measured before and after the charge-exchange reactions. (auth)

22989 HIGH CURRENT POSITIVE HYDROGEN ION SOURCE WITH MASS ANALYSIS. P. H. Rose, R. P. Bastide, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). *Rev. Sci. Instr.*, 32: 581-5 (May 1961).

A high current positive H_2^+ ion source with an extraction electrode, focusing system, and mass analyzer is described. The results of experiments on the apparatus for different geometries are presented. The difficulties involved in extracting and containing ion beams under space-charge forces are explored and a practical method for reducing the space-charge effects is described. It is shown that when space-charge densities of $\sim 30 \text{ ma/in.}^2$ are reached the optimum Einzel lens geometry is a function of beam current and beam diameter at the position of measurement. (auth)

22990 DYNAMIC MEASUREMENTS OF LOW MAGNETIC FIELDS WITH SPECIAL REFERENCE TO THE STRONG FOCUSING 1.2 GEV ELECTRON SYNCHROTRON AT LUND. Hans Nysäter (Royal Inst. of Tech., Stockholm). *Trans. Roy. Inst. Tech., Stockholm*, No. 174, 1-28 (1961). (In English)

A method employing "peaking strips" is developed to measure low magnetic fields (up to $2 \cdot 10^{-2}$ weber/m²) with high accuracy. The method is used to obtain the injection time behavior of the magnetic field of a strong focusing electron synchrotron. (auth)

22991 ELEKTROSTATICHESKIE USKORITELI ZARY-AZHENNYKH CHASTITS. (Electrostatic Accelerators of Charged Particles). B. M. Gokhberg and G. B. Yan'kov. Moscow, Atomizdat, 1960. 51p.

Accelerators using high voltage electrostatic generators are discussed. The design and construction of an electrostatic generator are analyzed, and characteristics determining the energy and stability of the accelerated ion beams are described. (R.V.J.)

Plasma Physics and Thermonuclear Processes

22992 (AD-251019) STUDY OF ELECTROMAGNETIC INTERACTIONS IN PLASMAS. Quarterly Progress Report No. 3, July 1, 1960 to September 30, 1960. R. W. Gould and D. G. Dow (California Inst. of Tech., Pasadena. Electron Tube and Microwave Lab.). Contract DA36-039 sc-85317. 21p.

Activities in a program of study are described which is devoted to the interaction of microwaves with plasmas and electron-beam systems for generation and amplification of microwaves and plasma diagnostics. Included are descriptions of research on cyclotron orbit plasma oscillations, high density plasma generation, and electromagnetic scattering from plasma columns. (J.R.D.)

22993 (AFCL-110) EXPERIMENTAL STUDY OF THE DIAMAGNETISM OF THE ELECTRON GAS IN GASEOUS PLASMAS WITH ELECTRON AND NUCLEAR SPIN RESONANCE TECHNIQUES. Scientific Report No. 8. T. C. Marshall, R. A. Kawcyn, and L. Goldstein (Illinois Univ., Urbana. Electrical Engineering Research Lab.). Nov. 1, 1960. Contract AF19(604)-2152. 183p. (AD-251753)

A critique of the diffusion theories of plasma diamagnetism is presented, and it is shown that, for strong magnetic fields, plasma diamagnetism results from an uncompensated microscopic current due to nonequilibrium phenomena. A theoretical expression is derived for the magnetic moment per unit volume of plasma: $M = -nk(T_e + T_i)/H(1 - \nu_{em}\nu_{im}/\omega_{He}\omega_{Hi})$. Experiments with low-pressure Hg vapor discharges showed the discharge magnetization to be linear in the magnetic field for very weak fields and to reach a maximum near 50 gauss with $M \sim -0.03$ to -0.06 erg/cm^3 gauss, in agreement with that predicted by the theoretical M equation. Pulsed Langmuir probe measurements of the electronic energies were also in good agreement with predictions. Observation of the phase change in the Larmor precession of protons in a homogeneous strong magnetic field of 1000 to 4000 gauss revealed a large diamagnetism in a pulsed discharge plasma. The diamagnetism was found to be a linear function of the power consumption and of the reciprocal of the magnetic field. Data were collected for Ar, Ne, and He discharges. The microwave method of increasing the energy density in d-c plasmas by resonance absorption was found to be several times more efficient than the conventional d-c current method, and the nature of very narrow electron cyclotron resonances in plasmas was studied. (D.L.C.)

22994 (AFCL-TN-60-1164) DENSITY FLUCTUATIONS IN A PLASMA IN A MAGNETIC FIELD, WITH APPLICATIONS TO THE IONOSPHERE. Scientific Report No. 1. T. Hagfors (Stanford Univ., Calif. Radioscience Lab.). Dec. 5, 1960. Contract AF19(604)-7436. 36p. (AD-248447)

General expressions are developed for the fluctuation density of electrons, ions, and charge in a plasma in thermal equilibrium in an external magnetic field taking only Coulomb interaction into account. The spectral distribution of the spatial Fourier components of the fluctuations is derived from basic principles. The fluctuations in electron density are discussed in some detail, and spectra are computed under conditions which are thought to prevail in the outer ionosphere. Frequency spectra of general validity are computed for electron-density fluctuations along the magnetic field. Examples show that the frequency

tra under ionospheric conditions are not much influenced by the magnetic field except for density fluctuations fairly close to perpendicularity to the magnetic field. Applications to incoherent backscattering are discussed, under suitable conditions, backscatter techniques are known to give valuable information about electron density, temperature, and constituents of the ionosphere. (auth)

95 (AFOSR-387) SPACE-CHARGE INSTABILITIES IN ELECTRON DIODES AND PLASMA CONVERTERS. K. Birdsall and W. B. Bridges (California Univ., Berkeley, Electronics Research Lab.). Jan. 26, 1961. Contract AF 49(638)-102. 34p.

Space-charge instabilities in diodes were found to produce variations in potential and current that are larger than predicted from classical static analyses and, moreover, which produce sustained electro-kinetic oscillations. The classical static solution is reviewed and the new transient solution is presented. As applications, tentative explanations are offered for recent observations of extra noise smoothing and of oscillations in thermionic converters. (auth)

96 (AFOSR-707) DIFFUSION FROM A SLIGHTLY PERTURBED REGION IN A UNIFORM FLOW. A. C. Pipkin (Maryland Univ., College Park, Inst. for Fluid Dynamics and Applied Mathematics). Apr. 1961. Contract AF 49(638)401. 21p. (BN-240)

A neutral gas is considered in steady one-dimensional motion, passing through a zone in which ionization takes place at a small given rate. The diffusion of the ions from the place where they are formed is investigated, with particular attention for the upstream diffusion. The neutral gas stream is regarded as a uniform background in which ion diffusion takes place. Of great importance is the definition of the electric field which results from the diffusion of the ions and strongly influences their motion. The application of the results to the case where a shock is present is discussed. (auth)

97 (AFOSR-757) THE USE OF A T-TUBE TO PRODUCE SHOCK-HEATED PLASMAS IN AN X-BAND WAVEGUIDE. J. M. Schecher (Maryland Univ., College Park, Inst. for Fluid Dynamics and Applied Mathematics). Apr. 1961. Contract AF 49(638)-401. 43p. (BN-245)

The shock wave produced by a T-tube with a sidearm expansion tube of 10 mm square cross section was investigated to find out whether it might be used to produce shock-heated plasmas in an X-band waveguide. Only weak shocks of Mach number less than 15 in argon at ambient pressures from 0.12 mm to 2 mm of mercury were studied. The investigation had two aspects. The theoretical and experimental results obtained by previous studies of strong shocks in T-tubes were applied. Experimental studies were also made on the tube. At Mach numbers less than 10 the velocity of the shock front was found to vary as the inverse square of the initial pressure and as the square of the applied voltage. The maximum volume of the shock-heated test plasma was found by theoretical considerations to be less than 1.2 cc. Drum camera pictures revealed the presence of additional fronts which moved slightly faster than the shock front itself. Several shocks were produced by the ringing of the discharge circuit. A summary is given of the knowledge of the thermodynamic variables of the test gas behind the shock front which can be obtained from drum camera photographs. It appears that the important parameters of electron temperature and density can be obtained by this means. (auth)

98 (JPL-TR-34-103) MAGNETOHYDRODYNAMIC FLOW OVER A DISK. M. C. Gourdine (California Inst. of

Tech., Pasadena. Jet Propulsion Lab.). Nov. 15, 1960. Contract NASw-6. 35p. (AD-251181)

The linearized equations describing the perturbations in applied, parallel, uniform, velocity, and magnetic fields, which are due to a flat circular broadside-on disk, are solved. The drag of the disk is derived in the form of an integral, and the integral is evaluated for large Hartmann number flows ($Ha \rightarrow \infty$). The drag coefficient is found to be $C_D = 2\pi Ha/Re$ where Re is the Reynolds number. (auth)

22999 (MATT-57) ON THE CORRESPONDENCE BETWEEN THE SOLUTIONS OF THE COLLISIONLESS EQUATION AND THE DERIVED MOMENT EQUATIONS. Carl Oberman (Princeton Univ., N. J. Project Matterhorn). Dec. 1960. 10p. Contract AT(30-1)-1238.

The use of a finite set of moment equations to describe the plasma when the width of the distribution is small is shown. Results can be obtained by this method to any desired power in the thermal spread which are in accord with asymptotic results of the Landau approach to the collisionless Boltzmann equation. The discussion is limited to the one-dimensional problems with one particle species for ease in presentation. The values of various assumptions were assayed. (M.C.G.)

23000 (NASA-TN-D-910) MAGNETIC IGNITION OF PULSED GAS DISCHARGES IN AIR OF LOW PRESSURE IN A COAXIAL PLASMA GUN. Karlheinz Thom and Joseph Norwood, Jr. (National Aeronautics and Space Administration, Langley Research Center, Langley Field, Va.). June 1961. 32p.

The effect of an axial magnetic field on the breakdown voltage of a coaxial system of electrodes was previously investigated. For low values of gas pressure times electrode spacing, the breakdown voltage was decreased by the application of the magnetic field. The electron cyclotron radius now assumes the role held by the mean free path in nonmagnetic discharges and the breakdown voltage becomes a function of the magnetic flux density. The dependence of the formative time lag as a function of the magnetic flux density is established and the feasibility of using a magnetic field for igniting high-voltage, high-current discharges is shown through theory and experiment. With a 36 microfarad capacitor bank charged to 48,000 volts, a peak current of 1.3×10^6 amperes in a coaxial type of plasma gun was achieved with a current rise time of only 2 microseconds. (auth)

23001 (ORNL-3123) PLASMA STABILITY ANALYSIS EMPLOYING EQUILIBRIUM CONSTANTS OF MOTION. T. K. Fowler (Oak Ridge National Lab., Tenn.). June 9, 1961. Contract W-7405-eng-26. 16p.

A first step in analyzing the stability of solutions of the Vlasov equation governing hot plasmas of low density is to solve the linearized equation for the perturbed space and velocity distribution function in terms of the perturbed electric and magnetic fields. An explicit Green's function solution for the distribution is presented and two examples of its use are given. The Green's function is found by first transforming to equilibrium constants of motion as variables. (auth)

23002 (PIBMRI-861-60) RADIATION FROM A POINT SOURCE IN AN ANISOTROPIC MEDIUM. E. Arbel (Brooklyn Polytechnic Inst. Microwave Research Inst.). Nov. 2, 1960. Contract AF-19(604)-4143. 248p. (AFRL-303)

A procedure is presented for the derivation of formal solutions to the problem of radiation from finite sources in the presence of gyrotropic regions. The boundary surface between adjacent gyrotropic regions constitute a set of parallel planes. The gyrotropic axis is perpendicular to the

boundary planes. The procedure was applied to the problems of radiation from a current element in an infinite and a semi-infinite plasma region. In both cases, the current element was oriented along the direction of the d-c magnetic field. Asymptotic expressions for the far field were derived by application of the saddle point method. In the case of an infinite plasma region with an infinite d-c magnetic field, explicit expressions were derived which are valid everywhere in space. The physical interpretation of the results is discussed in detail. In the case of an infinite plasma region, the radiation field due to a point source consists of several ray contributions. At the vicinity of a given observation point, each ray contribution behaves like a plane wave whose power flow is directed along the straight line from the point source to the observation point. A graphical construction is presented for the evaluation of the wave numbers of a plane wave from a given direction of the power flow. It was found that for some frequency ranges, the physical space can be divided into several regions by circular cones whose common axis is parallel to the d-c magnetic field and passes through the point source. The number of ray contributions is different in each of the conical regions. The configuration of the boundary cones is strongly affected by a change in the applied frequency. The ratio of the amplitudes of different rays at the same observation point, and of the same ray in different directions, depends on the nature of the point source. In the case of a semi-infinite plasma, a graphical construction for the optical paths is presented, by which the point of observation can be reached from the point source. This construction is based on reflection and refraction laws that relate the directions of the power flow in the incident and reflected (refracted) rays, rather than the direction of the phase gradients. The radiation field at a given observation point consists of ray contributions whose power flow is directed along the above optical paths. The amplitudes of the incident rays can be found from the results for the corresponding infinite region. The amplitudes of the reflected (refracted) rays are related to those of the incident rays via reflection or transmission dyadics, which are the analogs of the corresponding scalar coefficients employed in the isotropic case. A phenomenon of backward refraction was observed, whereby the incident and the refracted rays are located on the same side of the perpendicular to the boundary plane. In certain frequency ranges, where the point source is located inside the semi-infinite plasma region, curved caustic surfaces appear in the isotropic region. These surfaces are envelopes of well-defined groups of rays. The number of ray contributions at an observation point changes as the observation point moves from one side of the caustic surface to the other side. The shape of the caustic surfaces depends on the frequency range and on the location of the point source. (auth)

23003 (PLR-71) A TECHNIQUE FOR MAKING LOCAL MEASUREMENTS OF THE CONDUCTIVITY AND VELOCITY OF A PLASMAJET. Meredith C. Gourdine (Plasmadyne Corp., Santa Ana, Calif.). June 22, 1960. 15p. (AFOSR-365)

Discussions are given of the description and theory of a technique for measuring the local electric conductivity of a flowing plasma. An experiment is outlined for measuring the phase and amplitude differences of a magnetic field setup in the plasma as suggested by the technique. (B.O.G.)

23004 (PLR-86) MAGNETOHYDRODYNAMIC CHANNEL FLOW OF ROTATING FLUID. Meredith C. Gourdine (Plasmadyne Corp., Santa Ana, Calif.). Dec. 22, 1960. 15p. (AFOSR-138)

Considerations are given for an incompressible, viscous,

electrically conducting fluid in steady flow in a long cylindrical channel to which an external torque is applied to make the fluid rotate. Determinations were made of the distribution of rotational velocity in the channel, and the effects of the motion of the fluid on an uniformly applied magnetic field. (B.O.G.)

23005 (PLR-93) MAGNETOHYDRODYNAMIC SHEAR HEATING. Meredith C. Gourdine (Plasmadyne Corp., Santa Ana, Calif.). Feb. 2, 1961. 17p. (AFOSR-497)

The advantages of magnetohydrodynamic (MHD) shear heating for heating plasmas to high temperature are outlined. The case of MHD shear heating of mercury is analyzed and some experimental work reported. (D.L.C.)

23006 (TID-12328) PLASMA TURBULENCE RESEARCH, FINAL REPORT, JULY 20, 1959 TO OCTOBER 30, 1960. (Space Technology Labs., Los Angeles). Contract AT(04-3)-321. 59p.

A summary is presented of work done on plasma turbulence in controlled thermonuclear reaction devices. The technical progress is discussed in terms of fundamental aspects of plasma turbulence, energy transfer occurring in turbulent plasma, and thermal agitation and turbulence. Separate abstracts have been prepared for the three individual reports. (B.O.G.)

23007 (TID-12328(App. A)) PLASMA TURBULENCE. Leslie S. G. Kovaszny (Space Technology Labs., Los Angeles). Appendix A of PLASMA TURBULENCE RESEARCH, FINAL REPORT, JULY 20, 1959 TO OCTOBER 30, 1960. p.5-26.

The work takes into account the fact that turbulence can increase the electrical resistance of plasmas and cause serious deviations from the Spitzer relation between electrical resistance and temperature. Assuming the validity of the simple magnetohydrodynamic equations and considering only solenoidal turbulent velocity fluctuations, equations for the mean flow, mean electromagnetic field, and for the turbulent kinetic and turbulent magnetic energies of the fluctuating fields are obtained. The momentum equation for the mean flow contains stress terms contributed by the average double-velocity product. For a steady average state, these turbulent stresses must be balanced by magnetic pressure if hot turbulent plasmas are to be confined. The vector product of turbulent velocity and magnetic field fluctuations gives rise to a macroscopic electric field that opposes the d-c electric current density. This result can be presented as a macroscopic turbulent resistivity of the plasma and is essentially independent of the resistivity value obtained from the gas conductivity formula, from which it can differ by even an order of magnitude. The turbulent energy equations for both kinetic and magnetic turbulence indicate how the energy of the mean field is transferred first to kinetic turbulence, then from kinetic turbulence to magnetic turbulence, and how it is finally dissipated. (auth)

23008 (TID-12328(App. B)) ON THE ENERGY TRANSFER OCCURRING IN A TURBULENT PLASMA. Robert Betchov (Space Technology Labs., Los Angeles). Appendix B of PLASMA TURBULENCE RESEARCH, FINAL REPORT JULY 20, 1959 TO OCTOBER 30, 1960. p.27-33.

The energy of an element of plasma is the sum of three contributions: thermal energy, kinetic energy, and magnetic energy. The problems that may occur in a turbulent plasma can generally be viewed as an exchange between one form of energy and another. The physical mechanisms of turbulent resistivity and the process of energy exchange between the kinetic and magnetic modes were investigated. The results of the investigation indicate that kinetic turbu-

nt energy will grow at the expense of magnetic turbulent energy. (auth)

009 (TID-12328(App.C)) THERMAL AGITATION D TURBULENCE. R. Betchov (Space Technology Labs., s Angeles). Appendix C of PLASMA TURBULENCE RE-ARCH, FINAL REPORT, JULY 20, 1959 TO OCTO-ER 30, 1960. p.33-53.

An investigation of thermal agitation in ordinary fluids l plasmas was carried out. The study stresses the im-rtance of fluctuating forces introduced by atomic or lecular thermal agitation, such as Nyquist noise and ownian motion. The spectra of kinetic and magnetic es are derived from simple assumptions, and the re-ts are applied to shear flows. Since flow instability can mply the energy of a disturbance by factors of the order 10^7 , one finds that thermal agitation can be a cause of ulent behavior. The results may be useful to evaluate e sensitivity of measuring instruments in terms of al-to-noise ratios. (auth)

010 (TID-12982) GUIDE TO THE LITERATURE ON LASMA OSCILLATIONS. Technical Report No. 1. Win-on M. Gottschalk (Delaware. Univ., Newark). [1961?]. ntract AT(30-1)-2440. 27p.

A guide is presented to provide physicists and engineers ndicative program for approaching the technology of ve motion in plasma. The arrangement of the literature presented primarily for the benefit of the scientist who roaches the subject for the first time. (About 250 ref-ences.) (J.R.D.)

011 (NP-tr-594(p.15-19)) UTILIZING THE ACTION A MAGNETIC FIELD UPON A PENETRATING PLASMA ACQUIRING INTENSIVE IONIC BEAMS. M. D. Haba-a. Translated from Ukrain. Fiz. Zhur., 3: 693-4(1958). Methods are described showing that the focusing of pen-etrating plasmas for acquiring intensive ionic beams can be omplished with both electric and magnetic fields. A dis-ssion is given of the results of an investigation of plas-atic focusing in a copper cylinder with a coil mounted in iron supporting plate. (B.O.G.)

012 (NP-tr-639) ON THE DEVELOPMENT OF ELECTROSTATIC HIGH-VOLTAGE GENERATORS FOR EDIUM VOLTAGES (20-100 kV). F. Eckhart. Trans-ferred from Exptl. Tech. Physik, 3: No. 2, 49-57(1955). 18p. The mode of operation, construction, and characteristics electrostatic high-voltage generators for voltages of 20 50 kv are described. The advantages, in comparison to own machines, consist in the fact that they are con-structed circuit-symmetrically with the rotor in three rts and that the exciter plates are mounted over high-istance resistors. The weight of a generator of this e for 25 kv is about 170 g excluding the drive mecha-sm. The no-load voltage and the performance of the otors may be improved by compressed air. By means of itable stabilization of the voltage, the generators could used everywhere high d-c voltages are required at low tput as, e.g., for supplying electrical deflecting and age-reproducing systems. Whether this development n also be of significance for d-c transmission systems mains to be seen. (auth)

013 (NP-tr-669) INVESTIGATION OF ELECTRON NSITY IN A LINEAR PINCH BY MEANS OF 8.7 mm. VES. H. Hermansdorfer. Translated by E. Franklin .K.A.E.A. Atomic Energy Research Establishment) from Naturforsch., 15a: No. 11, 979-83(1960). 14p. This paper was previously abstracted from the original guage and appears in NSA, Vol. 15, abstract no. 10290.

23014 (TG-230-T220) INTERACTION OF SLOW PLASMA WAVES WITH A STREAM OF ELECTRONS. V. Ya. Kislov and E. V. Bogdanov. Translated by R. P. Illwitzer from Radiotekh. i Elektron., 5: 1974-85(Dec. 1960). 15p.

Studies made of the interaction of a slow electron beam with a gyrotropic plasma showed that E- and H-waves are separated even in the presence of a magnetic field. A criterion for separation is derived. The dispersion equation of a plasma-beam system is obtained for E-waves in a finite magnetic field and has two solutions, which corre-pond to the two possible interaction mechanisms. In the first mechanism space-charge waves are amplified as a result of deceleration of the electrons in the field of in-duced charges. In the second mechanism, the electron beam interacts with a retarded wave traveling through the plasma. Both space and surface waves can exist. The field amplitude of the space waves is maximum at the axis. The slow space waves have no counterpart in ordinary slow-wave structures. There are regions of both normal and anomalous dispersion for each of the two types. The features of interaction with a traveling wave are analyzed and the amplification factors are computed. Coupling impedances are calculated for both types of wave. Considerable signal amplification was achieved in experiments with both mechanisms. The ex-perimental results are in good agreement with theory. (auth)

23015 (TG-230-T236) STATISTICAL PARAMETERS OF AN ELECTROMAGNETIC WAVE WHICH HAS PASSED THROUGH AN INHOMOGENEOUS LAYER OF MAGNETO-ACTIVE PLASMA. N. G. Denisov. Translated by B. W. Kuvshinov from Izvest. Vysshykh Ucheb. Zavedenii, Radiofiz., 3: 619-30(1960). 17p.

On the basis of a solution obtained through the small perturbation method, the correlation functions were calcu-lated for amplitude and phase fluctuations of the field com-ponents of an electromagnetic wave propagating in a ran-domly inhomogeneous layer of a magnetoactive plasma. The fluctuations were calculated both for individual normal waves and for a wave which has an arbitrary linear polari-zation at the beginning of the layer. (auth)

23016 EMISSION OF RADIO-FREQUENCY WAVES FROM PLASMAS. G. Bekefi and Sanborn C. Brown (Mas-sachusetts Inst. of Tech., Cambridge). Am. J. Phys., 29: 404-28(July 1961).

Observations of the radio-frequency emission from extraterrestrial plasmas and from laboratory plasmas are described, and various attempts at interpretation of the re-sults are reviewed. Estimates are made of the probable loss of radiant energy from plasmas in proposed thermo-nuclear reactors. (auth)

23017 CONTROLLED THERMONUCLEAR REACTIONS. [PART] II. L. Th. M. Ornstein. Atoomenergie, 3: 77-83 (May 1961). (In Dutch)

Fusion experiments, such as the pinch experiments, magnetic mirrors, and the stellarator are described. En-ergy production with fusion reactors is considered, and a description is given of some uses of plasma physics in addition to fusion research. (tr-auth)

23018 ESTIMATION OF THE MAXIMUM TEMPERA-TURE IN A RADIALLY CONSTRICTED GAS DISCHARGE BETWEEN ELECTRODES. P. W. Seymour (Australian National Univ., Canberra). Australian J. Phys., 14: No. 1, 129-51(Mar. 1961).

A highly ionized, axially symmetric, steady state deute-rium plasma is considered. Bremsstrahlung and wall losses are assumed to be negligible compared to electrode losses.

A magnetic field is applied at the midpoint of the plasma, in order to constrict a section of the plasma to a small fraction of its unconstricted area. A function is obtained relating the area compression of the plasma to the maximum temperature achieved in the constricted area. (T.F.H.)

23019 ELECTRODE CONTAMINATION AND ARC FORMATION. H. de B. Knight (A.E.I. (Rugby) Research Lab., Rugby, Eng.). *Brit. J. Appl. Phys.*, 12: 282-7 (June 1961).

When the surface of the cathode of a gas discharge is contaminated with insulating substances or with mercury, the discharge may develop into an arc, with a lower voltage drop than is found with a clean cathode. Insulation particles are added to the electrodes of spark gaps designed to have a low impedance. With mercury, the minimum voltage and current values required for arc formation become lower with more effective mercury wetting of the electrode surface. Contaminants are important in the phenomenon of arc-back in arc rectifiers. The probability of arc-back depends on the random concentration of ions and also on the nature and extent of the contamination of the anode; this probability varies both with the conditions of operation and with previous treatment. The interpretation of tests made in 'synthetic' circuits, to determine the probability of arc-back in a rectifier in service, is discussed. (auth)

23020 STABILITY OF TUBULAR PINCH DISCHARGES. Paul Ginot (Commissariat à l'Energie Atomique, [Saclay, France]). *Nucleus (Paris)*, No. 2, 88-96 (Mar.-Apr. 1961). (In French)

The stability of tubular pinch discharges is investigated within the framework of magnetohydrodynamics. Two possible tubular configurations are considered, and the method of modes is used to examine the "Triax" configurations. The local stability and the inverse pinch configurations are reviewed, and the torsion of force lines in a Triax discharge is illustrated. (J.S.R.)

23021 ELECTROSTATIC SOUND WAVE MODES IN A PLASMA. F. W. Crawford (Stanford Univ., Calif.). *Phys. Rev. Letters*, 6: 663-5 (June 15, 1961).

To test the hypothesis that ion waves are a source of low-frequency fluctuations occurring in the parameters of d-c discharges, d-c mercury-vapor discharges of $\sim 1 \mu$ pressure were studied in tubes containing an oxide-coated spiral cathode, mounted transversely in a Mo cup. Results suggest that an electrostatic sound wave mechanism may be operating, and that it is enhanced by the presence of a constriction. (P.C.H.)

23022 ENHANCED DIFFUSION AND OSCILLATIONS IN WEAKLY IONIZED PLASMAS. Jean-François Bonnal, Georges Briffod, and Claude Manus (Centre d'Etudes Nucléaires, Saclay, France). *Phys. Rev. Letters*, 6: 665-7 (June 15, 1961).

The experiments were performed with a Reflex-type discharge in H_2 , N_2 , and Ar, with pressure, density, and magnetic field conditions variable. The discharge works in continuous mode. The diffusion is measured by means of the escape flux of the ions transverse to the magnetic field B_0 . The measurement is made with a probe external to the plasma, negatively polarized with regard to the plasma potential. The variation of the escape flux is plotted as a function of the magnetic field for different values of the pressure parameter. All curves show three separate regions. Relative variation of the noise-level with the magnetic field at 1000 Mc/sec is also shown. (P.C.H.)

23023 ON THE ELECTRON PLASMA OSCILLATIONS IN EXTERNAL ELECTRIC FIELD. A. I. Akhiezer, and A. G. Sitenko (Kharkov State Univ., and Inst. of Physics and

Tech., Academy of Sciences, USSR). *Zhur. Eksptl'. i Teoret. Fiz.*, 30: 216-18 (1956). (In Russian)

The frequency of electron plasma oscillations in a constant, uniform electric field was determined. (R.V.J.)

23024 THE PLASMA STATE. E. J. Hellund. New York, Reinhold Publishing Corporation and London, Chapman and Hall, Ltd, 1961. 199p. \$6.50.

The plasma state is examined from a phenomenological standpoint. The magnetic, electric, physical, and mechanical properties of plasmas are reviewed. Chemical reactions such as ionization and wall reactions, atomic reactions such as energy exchange processes, and nuclear fusion reaction in plasma are discussed. The arc plasma is studied in detail. The magnetohydrodynamic and electrohydrodynamic aspects of plasmas are examined. Plasma applications, such as cesium vapor converters, MHD generators, and plasma thermocouples are outlined. (T.F.H.)

23025 PHYSIKALISCHE ABHANDLUNGEN AUS DER SOWJETUNION. GASENTLADUNGS- UND PLASMAPHYSIK. FOLGE 1. (Physical Papers from the Soviet Union. Gas Discharges and Plasma Physics, Series 1). Physik. Abhandl. Sowjetunion, 10: 1-136 (1957). Leipzig, Akademische Verlagsgesellschaft Geest & Portig K.-G., 1957. 136p.

Nineteen papers are included; separate abstracts have been prepared for 16. Two papers were previously abstracted in NSA. (T.R.H.)

23026 SELF-EXCITATION OF EIGEN OSCILLATIONS IN GAS DISCHARGES AT HIGH PRESSURES. M. E. (J.) Gertsenshtein (Gerzenstein) (Moscow State Univ.). Physik. Abhandl. Sowjetunion, 10: 7-15 (1957). (In German)

The interaction of shock and electron waves in a gas discharge plasma is considered, and it is shown that spontaneous excitation at a certain frequency is possible. (tr-auth)

23027 THE DIELECTRIC PERMEABILITY OF A PLASMA IN A STATIONARY MAGNETIC FIELD. M. E. (J.) Gertsenshtein (Gerzenstein) (Moscow State Univ.). Physik. Abhandl. Sowjetunion, 10: 16-27 (1957). (In German)

The tensor for the complex dielectric permeability of an electron gas was calculated taking into account the thermal electron motion. (tr-auth)

23028 LOW-FREQUENCY PLASMA OSCILLATIONS. G. V. Gordeev (Gordejew) (Leningrad Mining Inst.). Physik. Abhandl. Sowjetunion, 10: 28-34 (1957). (In German)

Low-frequency plasma oscillations are treated. A conclusion is drawn from the dispersion formula for plasma oscillations in a constant electric field. It is shown that in the presence of a constant external field, stable undamped plasma oscillations are possible. (tr-auth)

23029 EXCITATION OF PLASMA OSCILLATIONS. G. V. Gordeev (Gordejew) (Leningrad Mining Inst.). Physik. Abhandl. Sowjetunion, 10: 35-40 (1957). (In German)

A study is made of the excitation of low- and high-frequency plasma oscillations by a beam of charged particles. In this connection, for the beam particles the temperature variation is regarded as their velocity. It is shown that a stationary condition of the plasma-beam system is unstable. In the absence of an external field the beam is dissipated, and the system transforms to the equilibrium state of the plasma. If there is a constant external field, a stable state of the system is possible with undamped high- and low-frequency plasma oscillations. (tr-auth)

23030 RELATIVISTIC PLASMA OSCILLATIONS. A. Akhizer (Akhieser) and R. Polovin (Polowin). Physik. Abhandl. Sowjetunion, 10: 50-2 (1957). (In German)

A treatment is presented in which no limitations are imposed on the electron velocity of the plasma, and the temperature is set at zero. The wave motion of an infinite plasma is examined with the assumption that the electron density and all the other variable quantities (electric field, electron velocity) produce functions of the linear combination $z - Vt$, where V is the velocity of a wave moving along the z -axis. Only longitudinal plasma oscillations with $|v||i, H = 0$ are considered. (T.R.H.)

2031 EXCITATION SPECTRUM OF A MANY-PARTICLE SYSTEM. V. (W) P. Silin (Lebedev Inst. of Physics, Academy of Sciences, USSR). *Physik. Abhandl. Sowjetunion*, 10: 53-60(1957). (In German)
Using an approximation of the binary distribution function, which permits taking into account the correlation limited by particle identity, the spectrum of a system of many particles was determined. It differs slightly from that obtained in an approximation with self-consistent interaction. It is shown that the approximation with self-consistent interaction is not useful for a degenerate electron-ion plasma, the interaction energy of the particles is comparable to greater than their kinetic energy. (tr-auth)

2032 THE ARTICLE "EXCITATION SPECTRUM OF A MANY PARTICLE SYSTEMS." V. (W.) P. Silin (Lebedev Inst. for Physics, Academy of Sciences, USSR). *Physik. Abhandl. Sowjetunion*, 10: 61-3(1957). (In German)
If one considers the particle correlation which results from identities, then one finds a different correlation for particles with equal and those with unequal spins. The binary distribution approximation is used when the particles have equal spins, and is altogether valid for Bose particles without spin. In the case of electrons, for example, one must use other considerations. (T.R.H.)

2033 AN APPROXIMATION CALCULATION FOR THE OSCILLATOR STRENGTH AND THE PHOTOIONIZATION CROSS SECTION. L. A. Vainshtein (Wainstein) and B. M. Ivorskii (Jaworski). *Physik. Abhandl. Sowjetunion*, 10: 1-12(1957). (In German)

A calculation was made of the oscillator strength for optical transitions and the cross section for photoionization and recombination with radiation using an approximated analytical single electron wave function. The results are compared with calculations by the self-consistent field method and with experimental data. It has led to an expression for the number of recombination processes with radiation. (tr-auth)

2034 DETERMINATION OF THE CROSS SECTION FOR COLLISIONS OF THE SECOND KIND FROM THE SENSITIZED FLUORESCENCE. S. E. Frisch and E. K. Kraulinia (Kraulinia) (Leningrad State Univ.). *Physik. Abhandl. Sowjetunion*, 10: 73-7(1957). (In German)

In the absence of a value for the cross section for collisions of the second kind, a study was made of the conditions for excitation of atoms in experiments with sensitized fluorescence. A gaseous mixture of Hg and Na is considered in which the Hg is optically excited and the Na is excited by collisions of the second kind with excited Hg atoms. Under these conditions it is presumed that the filling of the Na levels proceeds by two processes: (a) collisions of the second kind with excited Hg atoms, and (b) cascades from higher levels. It is found that not only can the weak transitions from high levels be disregarded, but also the strong transitions $4S \rightarrow 3P$ and $3D \rightarrow 3P$. The calculated value for σ is smaller than the measured value 1700. Thus it is shown that the resonance line of Na in the sensitized fluorescence spectrum is produced mainly by cascades. (T.R.H.)

23035 MOTION OF POSITIVE IONS IN A REAL GAS. Yu. (J.) M. Kagan and V. (W.) I. Perel (Karelian-Finnish State Univ.). *Physik. Abhandl. Sowjetunion*, 10: 78-82(1957). (In German)

The drift velocity is calculated according to the kinetic equation method, and from this comes the "stafette" or relay model. The results, in curves of drift velocity versus E/P , for Ar, Ne, and He, agree well with experimental data. Small differences can be explained by inaccuracies in the calculated q values. (T.R.H.)

23036 THE RELATION BETWEEN STATISTICAL THEORY AND COLLISION THEORY OF THE WIDTH OF SPECTRAL LINES. I. I. Sobelman. *Physik. Abhandl. Sowjetunion*, 10: 83-6(1957). (In German)

One of the main problems of the theory of line widths in atomic spectra produced by collisions of irradiating atoms with electrons, ions, and other atoms is the calculation of broadening integrals. The problem is discussed according to the reciprocal relationships and the useful limitations of the statistical theory and the collision theory. Only the density is considered, thus limiting the treatment to second collisions. (T.R.H.)

23037 EXCITATION MECHANISM OF VIBRATION LEVELS OF MOLECULES IN ELECTRIC DISCHARGES. N. Ya. (I.) Dodonova (Dodonowa) (Leningrad State Univ.). *Physik. Abhandl. Sowjetunion*, 10: 87-91(1957). (In German)

A study was made of the infrared radiation from a CO_2 equilibrium discharge at 0.2 to 5 Torr and a current of 0.02A. Electron temperature and E/P were measured simultaneously. (T.R.H.)

23038 THE DISSOCIATION OF MOLECULAR NEGATIVE IONS IN COLLISIONS WITH ATOMS. V. (W.) M. Kukelskii (Dukelski) and E. Ya. (J.) Zandberg (Sandberg) (Leningrad Physics - Technical Inst.). *Physik. Abhandl. Sowjetunion*, 10: 92-6(1957). (In German)

The dissociation of negative molecular ions at 300 to 800 eV was studied to give insight into the energy exchanges involved. The experiments were conducted in He and Ar with Te_2^- , Sb_2^- , Sb_3^- , Bi_2^- , NaI^- and NaI_2^- ions. The results indicate that the dissociations took place as transitions of the molecular ions in collisions to a higher unstable electron level, with subsequent decay. (T.R.H.)

23039 STUDY OF THE DEVELOPMENT VELOCITY OF THE LEADERS OF LONG SPARKS. M. (I.) S. Stekolnikov (Stekolnikow) and M. A. Bagirov (Bagirow) (Energy Inst., Academy of Sciences, USSR). *Physik. Abhandl. Sowjetunion*, 10: 101-7(1957). (In German)

A study was made of the leader velocity of long sparks (50 to 400 cm) as a function of the extinction resistance ($R_d = 0.74$ to 100,000 ohms) in the spark circuit, the electrode position, and the overvoltage (overvoltage factor $K = 1$ to 2). (tr-auth)

23040 THE IGNITION OF AN ELECTRIC GAS DISCHARGE BY ALTERNATING CURRENT OF ACOUSTICAL FREQUENCY IN TUBES WITH INNER AND OUTER ELECTRODES. N. A. Kapsov (Kapsow) and N. A. Popov (Popow) (Moscow State Univ.). *Physik. Abhandl. Sowjetunion*, 10: 108-14(1957). (In German)

A comparison was made of the ignition conditions and the discharges in tubes with outer and inner electrodes as a function of the frequency of the applied potential. In the case of outer electrodes, two kinds of discharge were found, one unstable at lower and one stable at higher potentials, with occasionally different ignition potentials. At about 10,000 cps the ignition potentials for both types of discharge as a function of frequency become closer. (tr-auth)

23041 DEVIATIONS FROM THE BOGUSLAWSKI-LANGMUIR LAW IN THE GLOWING OF THE TUNGSTEN CATHODE OF A VACUUM TUBE BY CURRENT PULSES OF LARGE DENSITY. S. V. (W.) Lebedev (Lebedev) (Lebedev Inst. of Physics, Academy of Sciences, USSR). *Physik. Abhandl. Sowjetunion*, 10: 115-132(1957). (In German)

In the glowing of a W cathode of a vacuum tube caused by high-density current pulses, the anode current exceeds the normal value given by the Boguslawski-Langmuir law by several times. The variation from this law is produced by a change in the state of the W under the influence of the dense current, and is not related to space charge neutralization by ions. (tr-auth)

23042 PINCHED PLASMA REACTOR. James A. Phillips, R. Suydam, and J. L. Tuck (to U. S. Atomic Energy Commission). U. S. Patent 2,991,238. July 4, 1961.

A plasma confining and heating reactor is described which has the form of a torus with a B_z producing winding on the outside of the torus and a helical winding of insulated overlapping turns on the inside of the torus. The inner helical winding performs the double function of shielding the plasma from the vitreous container and generating a second B_z field in the opposite direction to the first B_z field after the pinch is established.

23043 HIGH TEMPERATURE SYSTEMS. G. P. Thomson and M. Blackman (to U. S. Atomic Energy Commission). U. S. Patent 2,993,851. July 25, 1961.

A device is described for producing nuclear fusion reactions by additional acceleration of a hydrogen isotope plasma formed and initially accelerated by a collapsing magnetic field. The plasma is enclosed in a toroidal cavity within a vessel composed of a plurality of insulated coaxial segments. The added acceleration is caused by providing progressing potentials to the insulated segments acting as electrodes by means of a segmented delay transmission line coupled to the electrode segments and excited by a two phase alternating current supply.

Shielding

23044 (CEA-1310) ÉTUDE ET MISE EN PLACE DES BÉTONS DE PROTECTION DANS LE GÉNIE CIVIL DES OUVRAGES NUCLÉAIRES. (Design and Installation of Concrete Shielding in the Civil Engineering of Nuclear Constructions). F. Dubois. (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1960. 165p.

Technical information about high density concretes which are very important for radiation biological shielding is presented. The heavy aggregates (barytes, ilmenite, ferrophosphore, limonite, magnetite and iron punchings) used to make these concretes were investigated from the point of view of prospecting and physical and chemical characteristics. A general survey of shielding concretes was made involving the study of components and mixing and placing methods. A detailed investigation was also made of some high-density concretes: barytes concrete, with incorporation of iron punchings or iron shot, ferrophosphore concrete, ilmenite concrete, and magnetite concrete, more particularly with regard to grading and mix proportions and testing process. Two practical designs are described. Specifications are given for barytes concretes and for making the proton-synchrotron "Saturne" shielding blocks. (auth)

23045 (CERN-61-13) THE SHIELDING AND ITS HANDLING DEVICES FOR THE PS MACHINE. A. Acher-

mann (European Organization for Nuclear Research, Geneva). Apr. 13, 1961. 44p.

Various shielding blocks and handling devices were designed for general use around the proton synchrotron area. All these available facilities are enumerated, including their main characteristics, prices, delivery time, etc. Included in the survey are concrete blocks and girders, baryte blocks, lead blocks, steel blocks and girders, cast iron blocks, and handling apparatuses. (M.C.G.)

23046 (FZK-122) MILITARY FIELD EXPEDIENT SHIELDING EXPERIMENT. D. M. Wheeler and L. H. Bostick (Convair Nuclear Research and Development Lab., Fort Worth, Tex.). Oct. 18, 1960. Contract DA-44-192-ENG-13. 233p.

Experiments were performed to obtain data for use in applying field materials to shield portable nuclear-reactor power plants. Experimental data were obtained on neutron and gamma-ray attenuation and on neutron scattering for representative field materials and on air scattering of radiation. Field materials tested were dry sand, wet sand, clay, limestone, water, a soil mixture, and pine wood. Results of the experiments showed that a given thickness afforded more fast-neutron attenuation than gamma-ray attenuation. Secondary-gamma-ray production in expedient materials is an important consideration dependent on the water (hydrogen) content in the material. Significant amounts of radioactivity induced in expedient materials can be caused by trace elements. Activation tests of material samples from anticipated sites are desirable. Secondary-gamma rays produced in air are determined primarily by the type of reactor and shield and are a significant fraction of the air-scattered gamma-ray dose rate. (auth)

23047 (FZK-124) A STUDY OF SHIELDING REQUIREMENTS FOR MANNED SPACE MISSIONS. J. W. Keller (Convair, Fort Worth, Tex.). Oct. 10, 1960. Contract NASw-50. 108p.

The ramifications on shielding of manned space vehicles from the intense radiation environment in space was investigated. The radiation environment is reviewed and the problem of selecting shield materials in view of this environment is treated. The results of preliminary calculations to determine requirements for shielding against Van Allen radiation and solar protons are given. These results indicate that for most missions (outside the heart of the inner Van Allen belt) exposure to solar protons will be the controlling factor in determination of shield weight, suggesting the possible use of two crew compartments, one for normal operations and a smaller, heavily shielded one for short-term occupancy following solar flares. (auth)

23048 (NP-10306) DOSE ATTENUATION FACTORS FOR CONCRETE SLAB SHIELDS COVERED WITH FALLOUT AS A FUNCTION OF TIME AFTER FISSION. Technical Report No. 137. L. K. Donovan and A. B. Chilton (Naval Civil Engineering Lab., Port Hueneme, Calif.). June 1, 1961. 31p.

A study was made to determine the dose attenuation of fallout gamma radiation by various thicknesses of concrete roofs of buried personnel shelters. Dose attenuation factors are derived as a function of time after a nuclear detonation. (auth)

23049 (NP-10348) GAMMA RAY SCATTERING. Final Technical Progress Report for January 18, 1959 through June 18, 1961. John A. Wethington, Jr., R. A. Karam, C. A. Bisselle (Florida. Univ., Gainesville). Contract NOas 59-6015-c. 19p.

Studies were made of gamma scattering to see if any ef-

cts could be observed when solid shields were replaced with fine powders. Aluminum, copper, and lead powders of various sizes were used as shields in both narrow and broad beam geometry, and these powders were compared with the corresponding solid element. No differences were found. Experiments confirmed theoretical predictions that the addition of electrons to the surface of a metal should cause no observable change in the mass attenuation coefficient of the material. Pseudo mass attenuation coefficients for polyethylene and lead were determined in broad beam geometry. For certain thicknesses polyethylene attenuated gamma rays in a more efficient manner than lead of equivalent surface density. Final results obtained with the true photon spectra showed that shields made of polyethylene and lead were more efficient than lead shields. It was shown experimentally that it was not necessary to convert pulse-height data into photon spectra in order to obtain relative dose rates from the various shields. (M.C.G.)

23050 (NP-10349) GAMMA RAY SCATTERING. Tenth Quarterly Technical Progress Report for March 18, 1961 through June 18, 1961. John A. Wethington, Jr., R. A. Gram, and C. A. Bisselle (Florida Univ., Gainesville). Contract NOas 59-6013-c. 42p.

Final measurements were made on the shield configurations. Pulse-height spectra were converted into photon spectra, and dose rates from the various configurations were calculated. Six different sources of radiation were used to develop the inverse response matrix. The four shield configurations were lead alone, polyethylene on lead, lead on polyethylene, and laminated shield which consisted of alternate layers of polyethylene and lead sheets. The photon energy spectra of the scattered radiation emerging from the 4 slab configurations are shown in histogram form. Dose rates at the shield surface were computed. Data showed that the 3 combination shields are better than lead alone, with the laminated shield being best. (M.C.G.)

23051 (WAPD-T-1310) COMPARISON OF MEASURED AND CALCULATED THERMAL NEUTRON DISTRIBUTIONS IN HIGH TEMPERATURE WATER SHIELDING. D. C. Anderson, L. O. Herwig, and W. F. Vogelsang (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1960. Contract AT-11-1-GEN-14. 13p. Measurements taken in the core and reflector of the High Temperature Test Facility at Bettis are presented. The measurements are compared with calculated thermal neutron distributions obtained by spatially integrating Green's function, thus indirectly comparing the Green's function with experiment. (J.R.D.)

23052 (CEA-tr-A-903) CALCUL DES TEMPERATURES ET DES CONTRAINTES THERMIQUES DANS LES PROTECTIONS. (Calculation of Temperatures and Thermal Strains in Shielding). E. Schroeder. Translated into French by Z. Tilliette from Atomkernenergie, 4: 442-5 (1959). 22p.

The capture of thermal neutrons liberates energy in the form of γ rays. The γ rays are absorbed and produce heat. The distributions of temperatures and thermal stresses caused by this phenomenon in shielding are discussed. (tr-10)

Theoretical Physics

23053 (NP-10340) CHANGE OF VARIABLES AND EQUIVALENCE THEOREMS IN QUANTUM FIELD THEORIES. S. Kamefuchi, L. O'Riada, and T. D. Lee (Dublin Inst. for Advanced Studies), and Abdus Salam (Imperial Coll. of Science and Tech., London). [1961]. 35p.

The theorem proposed by Chisholm that the S-matrix in quantum field theories remains unchanged under any point transformation of field operators is discussed. A proof of the theorem is presented within the framework of the conventional canonical formalism of field theories. On the basis of the theorem, most of the ordinary equivalence theorems in field theories can be obtained by trivial changes of variables in the Lagrangians. The equivalence theorem for the Yang-Mills field is discussed in detail. (D.L.C.)

23054 (RM-2761(JPL)) PRINCIPLES OF INVARIANCE IN TRANSPORT THEORY. T. W. Mullikin (RAND Corp., Santa Monica, Calif.). Apr. 25, 1961. 26p. For Jet Propulsion Lab., California Inst. of Tech.

The transfer of radiation in a plane-parallel atmosphere is studied with a general and isotropic phase function which can vary with depth in the atmosphere. A solution to the transport problem is derived from the linear transport equation which satisfies Chandrasekhar's principles of invariance. A derivation of these principles within the framework of the transport equation is presented. (D.L.C.)

23055 (AD-251869) THEORETICAL DETERMINATION OF THE FINE STRUCTURE OF BORON-TYPE ATOMS. I. I. Glembotskii, I. T. Martishius, A. B. Bolotin, and A. P. Yutsis (Iutsis). Translated by Valys Zilius from Trudy Akad. Nauk Litovskoi S.S.R., Ser. B, No. 2, 15-19(1956). 4p.

The double splitting of the terms of four boron-type atoms in basic configurations was determined both with one-electron wave functions of a self-consistent Fock field, and with analytical wave functions. The theoretical results are compared with experimental data. (auth)

23056 (AEC-tr-4737) ZONE THEORY OF ONE-DIMENSIONAL LIQUID MODEL. A. N. Gubanov. Translated by Lydia Venters (Argonne National Lab.) from Zhur. Eksptl'. i Teoret. Fiz., 26: 139-? (1954). 16p.

The behavior of the electron in the field of one-dimensional atomic chain was investigated by using quantum-mechanical methods. By solving the Schrödinger equation in a deformed coordinate scale, it was shown that when the long-range order in the distribution of the atoms vanishes, i.e. when the chain becomes "melted", the energy spectrum of the electron maintains a zone structure, only the zone boundaries shift slightly. This conclusion agrees with a concept established experimentally that the electroconductivity of metals and semiconductors does not substantially change in melting, if the short-range order in the distribution of the atoms does not change. (auth)

23057 ENERGY LEVELS OF THE BOUNDED ISOTROPIC HARMONIC OSCILLATOR AND THE BOUNDED HYDROGEN ATOM BY THE METHOD OF BOUNDARY PERTURBATION. K. K. Singh (Univ. of Delhi). Inst. Sci. India, Pt. A, 27: 86-94 (Jan. 26, 1961).

It is shown that the theory of boundary perturbation can be successfully used to investigate the quantum mechanical behavior of the bounded isotropic harmonic oscillator and the bounded hydrogen atom for large values of the boundary parameter. Analytical expressions are obtained to represent the energy levels to the second order of approximation. The first order results are identical with those derived from different considerations. (auth)

23058 THE CORRELATED HARTREE-FOCK EQUATIONS AND THE GENERALISED DENSITY MATRICES. K. S. Viswanathan (Raman Research Inst., Bangalore, India). Proc. Indian Acad. Sci., Sec. A, 53: 169-94 (Apr. 1961). (In English)

Coulomb effects are incorporated into the Hartree-Fock (H-F) equations by multiplying the one-electron wave func-

tion by a correlation factor that is a function of the inter-electronic distances. The one-electron orbitals are found in the correlated H-F equations. The correlated equations are derived for the case of a non-stationary system. The generalized density matrices are derived, and, from these is obtained an expression for the energy matrix of the system. (T.F.H.)

23059 A LIMITING PROCESS IN QUANTUM ELECTRODYNAMICS. Alladi Ramakrishnan (Univ. of Bern), G. Bhattacharya, and S. Indumathi. *Proc. Indian Acad. Sci., Sec. A*, 53: 206-13 (Apr. 1961). (In English)

It is shown that the interaction between two charged particles reduces to that of a potential with one of the particles when the mass of the other tends to infinity. Recoil corrections, when one of the masses is finite and large, are also estimated in the cases of two-fermion scattering and of bremsstrahlung in the two-fermion interaction. (auth)

23060 CHARGE DISTRIBUTION OF THE PROTON. Y. R. Waghmare (Physical Research Lab., Ahmedabad, India). *Proc. Indian Acad. Sci., Sec. A*, 53: 214-18 (Apr. 1961). (In English)

An expression for the charge density of the proton is presented. The form factor calculated on the basis of this expression is compared with the experimental results. The

results are also compared with those of the exponential and the cut-off models. (auth)

23061 NOTE ON THE INTEGRAL REPRESENTATION OF COMMUTATORS. Kunio Yamamoto (Osaka Univ.). *Progr. Theoret. Phys. (Kyoto)*, 25: 211-14 (Feb. 1961).

The difference between the Dyson and Deser integral representations of commutators is discussed. It is shown that the vanishing region of the weight function cannot be determined for the Deser representation from the spectral condition. Hence, the forward dispersion relation for nucleon-nucleon scattering cannot be proved in the Deser sense from the integral representation alone. (auth)

23062 VALIDITY OF THE INTEGRAL REPRESENTATIONS FOR THE VERTEX PART IN PERTURBATION THEORY. Noboru Nakanishi (Kyoto Univ.). *Progr. Theoret. Phys. (Kyoto)*, 25: 296-7 (Feb. 1961).

An integral representation of the vertex part in perturbation theory is studied. This representation is a function of two mass variables. It is shown that, regardless of the validity of the Dyson integral representation of the vacuum expectation value for a double commutator, the integral representation of the vertex part is valid in every order of perturbation theory. (T.F.H.)

REACTOR TECHNOLOGY

General and Miscellaneous

0063 (AE-41) CALCULATION OF THE FLUX IN A SQUARE LATTICE CELL AND A COMPARISON WITH MEASUREMENTS. G. Apelqvist (Aktiebolaget Atomenergi, Stockholm). May 1961. 18p.

A calculation was made of the thermal neutron flux in a square lattice cell using methods devised by Galanin. The U^{235} and L^2 lattice parameters were expressed in measurable quantities and a comparison was made between measured and calculated values. (auth)

0064 (AEEW-R-52) ENERGY DEPOSITION AND RADIATION DAMAGE IN ORGANIC COOLED REACTORS. D. Jones (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England). Sept. 1960. 34p.

Methods of analysis are proposed for the evaluation of the rate of energy deposition by neutrons, gamma and beta radiations in organic-cooled reactors, for the purpose of estimating the rate of organic decomposition produced by radiolytic damage. The application of this analysis to three organic-cooled reactors is discussed and the results are presented. The three reactors comprise the experimental reactor OMRE and two proposed power reactor designs, one using organic liquid and the other using graphite as moderator material. The results for OMRE are used to deduce a new value of 0.37 for the G associated with neutrons in the OMRE organic liquid. This represents an increase of 16% on a value similarly deduced from the results of an analysis reported previously. The over-all G value for the mixed radiation field of OMRE also increases from the previously published value of 0.15 to 0.18. (auth)

0065 (AERE-M-845) FLUX MEASUREMENTS IN A JIMMY IN-PILE IRRADIATION FACILITY IN LIDO. H. R. McK. Hyder, C. J. Kenward, A. Green, and E. D. Jones (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1961. 7p.

The thermal and fast neutron flux perturbations produced by inserting a water-filled irradiation facility into the core of LIDO were measured by foil activation. (auth)

0066 (AERE-R-3633) ORGANIC LIQUIDS AS REACTOR COOLANTS. Review of Technological Information available July, 1959. K. Maddocks, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1961. 92p.

A review of information on the use of organic liquids as reactor coolants is presented. The review includes operating experience with the OMRE, properties of organic coolants, heat transfer, compatibility, and operation of systems containing organic coolants. (D.L.C.)

0067 (APDA-143) SUMMARY OF THE APDA FUEL DEVELOPMENT PROGRAMS. W. G. Blessing, J. S. Busch, J. G. Duffy, R. J. Hennig, W. H. Jens, F. W. Knight, C. Kovacic, D. O. Leeser, G. L. O'Neill, A. A. Shoudy, and R. G. Rateick (Atomic Power Development Associates, Inc., Detroit). Apr. 1961. 187p.

A summary is presented of the development status, through 1960, of work done on: Core A, the $U-10$ wt.% Mo metal and $U-3$ wt.% Mo blanket, and Core B, the UO_2 -SS cladding and the UO_2 axial blanket for the Fermi Fast

Breeder Reactor; advanced fast reactor fuels; and paste fuels. (B.O.G.)

23068 (DEG-Report-96) THE MULTI-GROUP ALBEDO METHOD. R. T. Ackroyd and J. M. Ball (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). May 15, 1961. 12p.

A multi-group version is given of the albedo method for calculating the critical sizes of fast cores with moderating reflectors. Fairly accurate results for critical sizes were obtained for bare spheres and cylinders of U^{235} and Pu^{239} without the need to adjust the core cross-sections, as in the simple albedo method which uses one group in the core and two groups in the reflector. The multi-group albedo method, because of its simplicity, is suitable for calculations on the interaction of arrays of fissile cores. The method can be applied also to cores of awkward shape without any difficulty. (auth)

23069 (GEAP-3639) INTERCOMPARISON MEASUREMENTS. William C. Ballowe, Walter R. Morgan, and John L. Russell, Jr. (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Jan. 18, 1961. 18p.

The experiments described are a comparison of rod bump-period, rod oscillator, rod drop, and pulsed neutron methods normally used for measuring control element strength in a multiplying system. The results show the rod oscillator technique to be dependent on detector locations. It is concluded that small reactivity changes are best measured by the rod bump-period technique while for large reactivities the pulsed neutron method is the only method of the four which has a straight forward interpretation. (auth)

23070 (HW-52834(Rev.)(Del.)) LATTICE PARAMETERS DERIVED FROM NEUTRON DISTRIBUTIONS. R. Nilson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 18, 1958. Decl. with Deletions July 29, 1960. Contract W-31-109-Eng-52. 31p.

Results of measurements at Hanford to improve and aid in evaluation of calculation methods for lattice parameters are reported. The correlation of results with theoretical values are encouraging. (J.R.D.)

23071 (JEN-66-DR/14) TEORIA DE LA PERTURBACION EN REACTORES NUCLEARES. (Perturbation Theory in Nuclear Reactors). G. Velarde (Spain. Junta de Energia Nuclear, Madrid). 1960. 46p.

The theory of perturbations is developed with several energy groups of prompt and delayed neutrons. (auth)

23072 (K-1478) EXTENSIONS OF NEUTRON INTERACTION CRITERIA. H. F. Henry, C. E. Newlon, and J. R. Knight (Oak Ridge Gaseous Diffusion Plant, Tenn.). July 11, 1961. Contract W-7405-eng-26. 43p.

The solid-angle method of calculating theoretical spacings between subcrits was extended and applied to large arrays of cylinders, to systems of units submerged in water, and to metal systems. The resulting predictions were compared with experimental data, and, in most of the cases evaluated the multiplication factor for the system of concern is found to be within $\pm 5\%$ of 1.00 for an experimentally measured critical system. For 5-in. cylinders in planar arrays as large as 10×10 , the spacing predicted by theory is found to be within 0.25 in. of the experimental values. (auth)

23073 (KAPL-M-RJR-4) A COMPARISON OF EXPERIMENTS AND THREE-DIMENSIONAL ANALYSIS TECHNIQUES. PART II. UNPOISONED UNIFORM SLAB

CORE WITH A PARTIALLY INSERTED HAFNIUM ROD AND A PARTIALLY INSERTED WATER GAP. R. J. Roseberry (Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 17, 1961. Contract W-31-109-Eng-52. 41p.

The experimental measurements and nuclear analysis of a uniformly loaded, unpoisoned slab core with a partially inserted hafnium rod and/or a partially inserted water gap are described. Comparisons of experimental data with calculated results of the UFO core and flux synthesis techniques are given. It is concluded that one of the flux synthesis techniques and the UFO code are able to predict flux distributions to within ~5% of experiment for most cases, with a maximum error of ~10% for a channel at the core-reflector boundary. The second synthesis technique failed to give comparable agreement with experiment even when various refinements were used, e.g. increasing the number of mesh points, performing the flux synthesis technique of iteration, and spectrum-weighting the appropriate calculated fluxes through the use of the SWAKRAUM code. These results are comparable to those reported in Part I of this study. (auth)

23074 (MIT-OR-6) METHODS FOR DETERMINING FUEL BURNUP. R. L. Stover and G. K. Moeller (Massachusetts Inst. of Tech., Oak Ridge, Tenn. Engineering Practice School). July 5, 1961. For Oak Ridge National Lab. Contract W-7405-eng-26, Subcontract 70. 59p.

Two standardized definitions for use in reporting of fuel burnup are recommended: fission density and percent fissionable isotope depletion. Experimental methods for determining burnup parameters are summarized and compared. Methods discussed include radiochemical analysis, mass spectrometry, optical spectrometry, and neutron activation. Formulas for determining burnup from activation analysis and from isotopic analysis data were derived. The accuracy of these formulas is discussed. A brief summary is given of analytic methods for determining burnup. (auth)

23075 (MND-M-2575) PM-1 AIR-COOLED CONDENSER TEST PERFORMED AT THE CLIMATIC LABORATORY, EGLIN AFB, FLORIDA [DURING THE PERIOD JANUARY 3, 1961-MARCH 10, 1961]. M. B. Eck and J. F. Holliday (Martin Co. Nuclear Div., Baltimore). Contract AF29(601)-4301. 201p.

A single module of the PM-1 four-module condensing system was tested over an ambient temperature range of +70° to -65°F. All modes of normal operation, transportation and handling, as well as some emergency conditions, were imposed on this condenser section during the test period. The unit was shown to have an adequate margin of safety in all of its design parameters. The calculated overall heat transfer coefficient was exceeded by 5.3%. The air side pressure drop was 17.2% less than predicted. The total power requirement for the design heat load was, when extrapolated to 6500 feet elevation, 10% less than predicted. It was shown that the total PM-1 plant load can be carried by three sections (at sea level) at ambient temperatures below approximately 50°F. The entire condenser can operate well below its minimum flow requirement of 2400 lb/hr at all ambients and it was shown that the air cooler can cover the range of 400 to 750 lb/hr at all ambient temperatures. Modifications were made to the unit during the test to achieve this performance. These modifications included the addition of flow guides and orifices to the air cooler tube inlets, the addition of air baffles to the main bank and air cooler tubes, a change in the location of the condensate outlet connection, and a change to the air cooler water box division plate drain ports. The ability of the unit to be

transported aboard a C130A Air Force cargo plane was demonstrated. With the adoption of the recommendations given the PM-1 condensing system should perform adequately and reliably in extended field service. A table summarizing the safe operating configurations of the PM-1 condenser unit is included. (auth)

23076 (NAA-SR-4989) ANALYSIS OF FUELED IRRADIATION CAPSULES WHICH FAILED IN THE MATERIALS TESTING REACTOR. D. G. Harrington (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 15, 1961. Contract AT(11-1)-GEN-8. 47p.

Two instrumented irradiation capsules, containing NaK-bonded U-10 wt.% Mo fuel, failed in the Materials Testing Reactor. A detailed investigation of the incident indicated that the failures were probably caused by an improper heat treatment causing sensitizing of the stainless steel capsule shell, in combination with excessively high local stresses adjacent to spacing rings, and an environment favorable to stress corrosion cracking. Means for avoiding the first two conditions are recommended. (auth)

23077 (NAA-SR-Memo-4565(Rev. 1)) REACTOR VESSEL BELLOWS. J. Susnir (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif. Mar. 1, 1961. 19p.

Two types of bellows configurations were proposed for the HNPf Reactor Vessel. It was established that the only logical manner of comparing the two designs is on an actual stress basis which implies equal life for each bellows. Results are presented giving the minimum number of convolutions required for each design. (auth)

23078 (NAA-SR-Memo-5950) PRESSURE BUILDUP IN OMRE CONTROL RODS. W. B. Wolfe (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 16, 1960. 8p.

The pressure buildup in one of the B₄C control rods of the inner bank in the OMRE after a cumulative exposure of 1863 Mwd is calculated to be 415 psi at 600°F. The B¹⁰ depletion in each of the inner rods is 1.3%. (D.L.C.)

23079 (NAA-SR-Memo-6072) STRUCTURAL EVALUATION OF PROPOSED ASCR MODERATOR CANS. William F. Anderson (Atomic International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 31, 1961. 29p.

The principle problem in moderator can structure was that of buckling of the cladding. Results of an investigation of the buckling provided analytical expressions relating cladding material properties, pressure differentials and loadings, and thermal stresses to the possibility of buckling and the characteristics of buckles which do form. Relations obtained for both elastic and plastic buckles allow an estimate of these variables on the possibility of fatigue failure of the cladding. The derived expressions were applied to two of three proposed can designs and an estimate made of the requirements of the third design. From the results obtained, possible development of satisfactory, economic stainless steel cans appeared to be very questionable. Zirconium alloy 321 appeared to have the properties which indicate successful development of a 7-hole can and possibly 12-hole and 19-hole cans also. Zircaloy II may be equally successful. The major buckling problems not answered by this analysis were the possibility of shear buckles near the heads and creep buckles under high temperature operating conditions. (auth)

23080 (NAA-SR-Memo-6103) HYDRAULIC TESTS OF A PROTOTYPE HALLAM FUEL ELEMENT (SU-9) TO BE

TESTED IN SRE. R. J. Begley (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 13, 1961. 25p.

Pressure-drop measurements were made across a mockup of a Hallam prototype fuel element in a test section installed in the Hallam Hydraulic Loop. The flow channel was identical to an SRE fuel channel and included simulated upper and lower plenums. The fuel element mockup was equipped with a Hallam-type variable orifice at the channel exit and a fixed orifice in the strainer basket at the bottom of the element. Tests were performed to determine the optimum size for the fixed orifice and the temperature adjustment capability of the variable orifice using this optimum fixed orifice. To obtain the predicted 4.1 lb/sec sodium coolant requirement at a core pressure drop of 0.85 psi, a $\frac{1}{4}$ in. fixed orifice was determined to be the optimum. With this fixed orifice size the variable orifice will be approximately 1 in. withdrawn during full-power operation. Adjusting the orifice over its entire range of 0 to 1 in. from fully inserted to fully withdrawn covers a temperature range from 875 to 1040°F which is approximately 80°F about the normal outlet temperature of 960°F. Curves are presented for use in determination of operating characteristics of the element with other fixed orifice sizes should the core pressure drop or required flow rate of coolant be changed. (auth)

3081 (NAA-SR-Memo-6212) DATA REDUCTION TABLES FOR REACTIVITY MEASUREMENTS. L. Beller (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 21, 1961. 13p.

A Fortran code for the IBM-7090 is described which calculates a set of data reduction tables for use in asymptotic reactivity measurements. From the ratio of reactor power at two different times during a period measurement, the table supplies the period and corresponding reactivity to a maximum precision of 1 to 2%. (D.L.C.)

3082 (NAA-SR-Memo-6214) INTRACELL MEASUREMENTS WITH A URANIUM CARBIDE FUEL ELEMENT IN A HALLAM EXPONENTIAL LATTICE. O. R. Hillig (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 23, 1961. 34p.

Measurements were made in and about a single uranium carbide fuel element to determine several intracell parameters. They are thermal utilization, the ratio of the resonance to thermal captures in U^{238} , and the ratio of U^{238} to U^{235} fissions. The measurements were made on a 12-rod uranium carbide fuel element inserted into the center of a hexagonal lattice where the remainder of the fuel elements are of the 19-rod U-10 Mo type. A description of the lattice cell studied, graphs of the neutron flux distributions in the various materials in each cell, the relative average thermal neutron flux for each material, and the values of the lattice parameters obtained are included. (auth)

3083 (NAA-SR-Memo-6261) ANALYSIS OF CONTROL ROD WORTH MEASUREMENTS MADE IN THE HALLAM CRITICAL EXPERIMENT. D. S. Bost (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 15, 1961. 14p.

Data from the measurement of control rod worth in the Hallam Critical Experiment were used to determine the worth of similar rods in the HNPFC Core. Two methods of analysis were employed. Using the first method, it was found that the calculation of the thermal worth of a centrally located control rod in the critical assembly did not agree with the measured thermal worth. Since the calculated and measured total worth was in agreement, it was concluded that the epithermal absorption rate in the rods

was being overestimated. A revised calculational model was devised to enhance the effect of thermal neutron absorption. This revised model gave reasonable agreement with the measured thermal and total worth and thus was used to determine the worth of the HNPFC Control rods. (auth)

23084 (NDA-2561-2) INSPECTION PROCEDURE FOR BR-2 FUEL ELEMENTS. M. Langham and E. VanMuldres (Nuclear Development Corp. of America, White Plains, N. Y.). Dec. 31, 1958. For Centre d'Etudes pour les Applications de l'Energie, Brussels. 46p.

Techniques, equipment, and inspection procedures were developed for the metallurgical and dimensional acceptance examination of fuel elements for the Material and Engineering Test Reactor (BR-2). Steps in the procedure include visual inspection, dimensional verification, checking of the cladding thickness, and ultrasonic testing of core-to-cladding bond integrity. The use of radiography and fluoroscopy in determining the core location and homogeneity of the core alloy is discussed along with the need for chemical analysis of the core. The BR-2 fuel element specification is also included. (M.C.G.)

23085 (NYO-2797) QUARTERLY PROGRESS REPORT [ON REACTOR FUELS]. Period Ending April 30, 1959. (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2264. 18p.

The problems of coating UO_2 spherical particles for use in dispersion fuel elements were investigated. UO_2 spheroids were prepared and coated with Cr by four methods and with Nb by reduction of the halide with H_2 . The conditions of each coating method for best results were examined. UO_2 spheroids coated with Cr by vapor deposition were blended with Zircaloy-2 powder and the mixture cold-pressed and extruded into a strip. X-ray examination of the strip shows the UO_2 particles to be intact and without cracks or stringers and the coatings to be retained by the particles. (D.L.C.)

23086 (PAN-218/IX) ALBEDO PROBLEM FOR A SLAB. R. Zelazny and A. Kuszell (Polish Academy of Sciences, Inst. of Nuclear Research, Warsaw). Mar. 1961. 6p.

A new application of the method developed by K. M. Case in the one-velocity neutron transport theory is presented. The albedo problem, with prescribed incident neutron beams on both surfaces of the slab, was solved by reducing the problem of solving the Boltzmann equation to the problem of solving a Fredholm type integral equation for the expansion coefficients. (auth)

23087 (VDIT-24) BOILING WATER REACTORS CONTROL AND STABILITY. A Selective Bibliography. Ernst Bock (Aktiebolaget Atomenergi, Stockholm). [1960]. 27p.

Seventy-eight references, with abstracts, on control and stability of boiling water reactors are given. This material includes publications from 1950 to 1960. The references are arranged under the following headings: general and miscellaneous, the Experimental Boiling Water Reactor, the Special Power Experimental Reactor Test, the Boiling Reactor Experiment, the Halden Reactor, and special types. (M.C.G.)

23088 (VDIT-39) NUCLEAR REACTORS HAVING STAINLESS-STEEL CLAD FUEL ELEMENTS. (A Survey). W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). May 1961. 21p.

Twenty-four reactors containing stainless steel clad fuel elements together with some dimensional data concerning

the cladding and the elements themselves are listed. Abstracts of 63 publications pertaining to the fabrication of stainless steel clad fuel elements issued from 1958 to 1961 are also included. (M.C.G.)

23089 (WAPD-T-1307) EXPERIMENTAL AND CALCULATED ACTIVATIONS IN A ONE-DIMENSIONAL SLAB CORE WITH ZIRCONIUM-H₂O REFLECTOR. J. Korsmeyer, C. Bolmgren, and S. Milani (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-1-GEN-14. 35p.

Experimental and calculated activation shapes were compared along a traverse through the heterogeneous dimension of a slab core homogeneous in the other two directions. The core featured a 20-inch Zr-H₂O reflector region on one side. Bare Mn foils and Cd-covered In, Au, and depleted U-238 foils provided experimental data throughout the reflector and the adjacent fuel region. Calculations utilized few group P-1, multigroup P-1, several group P-3 and thermal multigroup double P-1 approximations to obtain flux values. Multigroup detector cross sections were also obtained. The use of P-3 fast and epithermal fluxes in the Zr-H₂O reflector is shown to be necessary to match experiments. The activation shapes of Cd-covered In and Au are shown to be insensitive to the variation of the foil cross sections with energy in the Zr-H₂O reflector. (auth)

23090 (WAPD-T-1308) TECHNIQUE FOR ANALYZING PARTIAL WATER HEIGHT EXPERIMENTS. W. B. Doub and J. E. Mott (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1961. Contract AT-11-GEN-14. 25p.

The technique for analyzing a typical partial water-height experiment is reviewed. It is pointed out that the basic parameter measured in such an experiment is the buckling coefficient of reactivity, $(\Delta\rho/\Delta B^2)$, for the critical reactor, and that comparison with theory should be made on the basis of the calculated and the measured value of $(\Delta\rho/\Delta B^2)$ at criticality and not on the excess reactivity as was done previously. Application of this technique is made on partial water-height measurements of heterogeneous, water-moderated, water-reflected, highly-enriched cores with a zirconium metal-to-water ratio of 1.3. The results of the measurements are compared with calculations. In the present cases it was desired to test the accuracy of two sets of fast-neutron cross sections referred to as Tape 5 and Tape 0 respectively. Although many differences exist in the two tapes the most important one is the non-zero zirconium inelastic-scattering matrix appearing in the Tape 5 set of cross sections. The results of the comparisons of the measured values of $(\Delta\rho/\Delta B^2)$ and the calculated values using Tape 5 and Tape 0 show that Tape 5 gives best agreement. It is noted that $(\Delta\rho/\Delta B^2)$ is also sensitive to the thermal cross sections and that a Wigner-Wilkins spectrum gives better agreement than a Maxwellian spectrum. It was found in the course of the calculations that the value of $(\Delta\rho/\Delta B^2)$ was incorrectly computed if small changes in the fast neutron spectrum caused by small changes in core size were not considered. (auth)

23091 (AEC-tr-4545) THE WIGNER RELEASE IN GRAPHITE-MODERATED REACTORS. C. Dalmasso and G. F. Nardelli. Translated from *Energia Nucleare* (Madrid), 6: 307-21(1959). 21p.

The behavior of irradiated graphite in annealing experiments is studied from the point of view of the Wigner release. Radioinduced lattice defects are examined, and in a few simple cases the behavior of macroscopic properties during annealing experiments is studied. It is suggested that the phenomenological theory of annealing by means of

processes distributed in the activation energy presents a good approximation of postirradiation annealing. (D.L.C.)

23092 (JPRS-8181) ANNUAL REPORT OF NETHERLANDS REACTOR CENTER FOR 1959. (translation). (Netherlands. Reactor Centrum, The Hague). 64p.

The activity of the foundation in 1959 was to a great extent directed to the building of the research center in Petten, and educating and preparing the staff that will work there. Topics covered in the report include the center at Petten, the High-Flux Reactor, physics, chemistry and construction materials, health protection, design, personnel and housing, training, library and documentation, the Suspension Reactor Project, the ultracentrifuge for isotope separation, patents, organization of the R.C.N., Dutch commerce and industry, international cooperation, and financial report. (M.C.G.)

23093 REACTOR FUEL HANDLING PROBLEMS. PLUTONIUM RECYCLE TEST REACTOR OPERATION. W. E. Cawley (General Electric Co., Richland, Wash.). *Atompraxis*, 7: 131-5(Apr. 1961). (In English)

The problems encountered when handling unirradiated, irradiated, and ruptured fuel elements are discussed from a general point of view. The solution of these problems in the case of the elements of the Plutonium Recycle Test Reactor is described. (auth)

23094 APPROXIMATE CALCULATION OF THE OPTIMUM LATTICE-SPACING OF URANIUM-RODS. Harry N. Schludi. *Atompraxis*, 7: 142-6(Apr. 1961). (In German)

In order to determine the optimum lattice spacing of uranium rods a formula was derived. This formula makes possible an analytical computation of the optimum lattice spacing and avoids a graphical determination. An investigation of lattice spacing in the best-known moderators shows that only with hydrogen and beryllium can a small lattice spacing (and therefore high power density) be achieved. The optimum lattice spacing is practically only a function of the slowing-down power of the moderator. (auth)

23095 CHEMO-NUCLEAR REACTORS-A SURVEY. H. Krauch (Studiengruppe für Angewandte Radio- und Strahlenchemie, Heidelberg, Ger.). *Atomwirtschaft*, 6: 261-5 (May 1961). (In German)

Nuclear chemistry has manifold roles, starting with the processing of raw and special materials up to the processing of irradiated fuels. Nuclear energy offers new possibilities for the field of chemistry, i.e., effects of ionizing radiation, use of radionuclides for analysis etc. Nuclear chemistry, radiochemistry and radiation chemistry are new lines of science and engineering resulting out of this reciprocal effect. (auth)

23096 THE ORGANIC REACTOR AS A CHEMO-NUCLEAR EXPERIMENTAL REACTOR. L. Wiesner. *Atomwirtschaft*, 6: 269-72(May 1961). (In German)

The organic moderated and cooled reactor offers a decisive development possibility as a chemo-nuclear reactor for bringing about industrially interesting chemical reactions in its coolants or in suitable admixed substances. The reactor, because of this secondary production, could become interesting from the point of view of costs for power production. Otherwise, with the presently foreseeable possibilities of development, it is hardly likely to result in essentially lower costs than the correspondingly developed pressurized water reactor. (auth)

23097 THE GENERALIZED NYQUIST'S DIAGRAM AND ITS APPLICATION TO THE STUDY OF THE STABILITY OF NUCLEAR REACTORS. A. Blaquiére (Institut National

Sciences et Techniques Nucléaires, Saclay, France).

Bull. inform. sci. et tech. (Paris), No. 41, 1-12(1960).

EA-1700). (In French)

The method of Nyquist, introduced in relation to feed-back loops, may be generalized and is particularly adaptable to the study of nonlinear loops. The method introduced for the study of oscillators is described and how it can be applied to the study of the stability of nuclear reactors is shown. The basis of the method is to replace the analytical function $H(\omega)$ used by Nyquist to describe the operation of a feed-back loop, in which the parameter ω is the operating frequency, by a more complete function $H(a, j\omega)$ which involves two parameters: a and ω , amplitude and operating frequency. It is then easy to see how the method of Nyquist is generalized. In the linear case, the representation in the complex plane of the function $H(j\omega)$, obtained by varying the real parameter a from $-\infty$ to $+\infty$, is a curve the position of which in relation to the origin shows if the operating conditions are stable or unstable. In the nonlinear case, the same graphic method leads to a family of curves of the above type, depending from the amplitude parameter a . According to the amplitude values, the system is then stable or unstable, whence a discussion defining the stability zones and fixing the limiting amplitudes. As far as nuclear reactors are concerned, the case ω is fixed by a sinusoidal variation of reactivity. The amplitude a is defined by the power level around which the operation is carried out. (auth)

2098 EXPERIMENTS AT THE SECTION OF MECHANICS. R. Martin and E. Maillet. Bull. inform. sci. et tech. (Paris), No. 50, 29-34(Apr. 1961). (In French) The correct behavior and the safe operation of materials and mechanisms which constitute the core of reactors and their control and fuel removal facilities require numerous tests supplementing design calculations. The methods and means used by the Section of Mechanics for studies on the structure and dynamics of prototype power reactors and in critical assemblies are reviewed. (J.S.R.)

2099 EXPERIMENTAL EVALUATION OF THE CALCULATION OF PHYSICAL PARAMETERS OF DESIGNED NUCLEAR REACTOR WITH THE AID OF ZERO POWER CRITICAL ASSEMBLY. Frantisek Klik (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Prague). Jaderná energie, 7: 110-16(Apr. 1961). (In Czech) A study is conducted, dealing with the problems of experimental evaluation of calculations and with the design of heterogeneous natural uranium-heavy water reactors. General problems are noted. Some conclusions are applicable also to other types of thermal nuclear reactors. (auth)

2100 BURNOUT SAFETY OF A NUCLEAR FUEL ELEMENT. Václav Stach (Inst. for Nuclear Research, Czechoslovak Academy of Science, Prague). Jaderná energie, 7: 146-50(1961). (In Czech) The properties of materials have a limiting effect on the working temperature of the fuel elements in a nuclear reactor. The maximum permissible temperature in reactor design must include certain safety factors to compensate for the effects of computation inaccuracies, production and operation tolerances, and failures of reactor measurement and control systems. It is possible to determine this temperature only on the basis of experimental data obtained during the development of a fuel element. A safety factor method is presented, which provides, for a given purpose, an exact evaluation of experimental results. Statistical modifications of this method abandon the assumption of incidences of all unfavorable influences. The use of the safety factor method for successive evaluation of experi-

mental data in individual stages of reactor design gives results for further experimental work and finally for finding guides for the testing and permanent operation of a reactor. (auth)

23101 ON THE STATE OF PHYSICS OF HEAVY WATER REACTOR LATTICES. Jaderná energie 7: 158-66(1961). (In Czech)

A report on heavy water reactor lattices is reviewed. The report describes computation and experimental methods in current use, various laboratory programs, and proposed development experiments. (auth)

23102 SL-1 ACCIDENT. Atomic Energy Commission Investigation Board Report. (United States. Congress. Joint Committee on Atomic Energy). June 1961. 173p.

The SL-1 accident, January 3, 1961, took the lives of three persons. This report summarizes the current information pertaining to the circumstances surrounding the explosion within the reactor vessel. The evidence strongly indicates a nuclear incident of 50 Mw-sec or more which could credibly be induced by rapid and extensive motion of the central control rod. There is no evidence to show that the actions of the operators on duty were in any way different than those prescribed and which had been carried out without incident many times before. (N.W.R.)

23103 REACTOR CORE MATERIALS. Technical Progress Review, Vol. 4, No. 2. R. W. Dayton, E. M. Simmons, and R. W. Endebrock, eds. (Battelle Memorial Inst., Columbus, Ohio). May 1961. 190p.

Fuel and Fertile Materials. A review is presented of developments in uranium, α -uranium alloys, γ -uranium alloys, ϵ -uranium alloys, plutonium and its alloys thorium, refractory fuel and fertile materials, dispersion fuels, mechanisms of corrosion of fuel alloys, and basic studies of radiation effects in fuel materials. Moderator Materials. Developments are described for graphite, beryllium metal and alloys, beryllium compounds, and solid hydrides. Nuclear Poisons. Research and developments are reported in metallic poison materials, and dispersion absorber materials. Cladding and Structural Materials. Studies are described for corrosion, radiation effects in nonfuel materials, selected metallurgical aspects of cladding and structural materials, and selected mechanical properties of cladding and structural materials. Special Fabrication Techniques. A review is given of developments in melting and casting, cladding, welding and brazing, and nondestructive. (B.O.G.)

23104 NUCLEAR REACTOR CONTROL SYSTEM. Donald F. Howard and E. E. Motta (to U. S. Atomic Energy Commission). U. S. Patent 2,990,353. June 27, 1961.

A method for controlling the excess reactivity in a nuclear reactor throughout the core life while maintaining the neutron flux distribution at the desired level is described. The control unit embodies a container having two electrodes of different surface area immersed in an electrolytic solution of a good neutron absorbing metal ion such as boron, gadolinium, or cadmium. Initially, the neutron absorber is plated on the larger electrode to control the greater neutron flux of a freshly refueled core. As the fuel burns up, the excess reactivity decreases and the neutron absorber is then plated onto the smaller electrode so that the number of neutrons absorbed also decreases. The excess reactivity in the core may thus be maintained without the introduction of serious perturbations in the neutron flux distribution.

23105 SEPARATING LIQUID MODERATOR FROM A SLURRY TYPE REACTOR. Harcourt C. Vernon (to U. S. Atomic Energy Commission). U. S. Patent 2,991,236. July 4, 1961.

A system for evaporating moderator such as D_2O from an irradiated slurry or solution characterized by two successive evaporators is described. In the first of these the most troublesome radioactivity dissipates before the slurry becomes too thick to be pumped out; in the second the slurry, now easier to handle, can be safely reduced to a sludge.

23106 FUEL ELEMENTS FOR NUCLEAR REACTORS. Alan Blainey and Henry Lloyd (to U. S. Atomic Energy Commission). U. S. Patent 2,992,172. July 11, 1961.

A method of sheathing a tubular fuel element for a nuclear reactor is described. A low melting metal core member is centered in a die, a layer of a powdered sheathing substance is placed on the bottom of the die, the tubular fuel element is inserted in the die, the space between the tubular fuel element and the die walls and core member is filled with the same powdered sheathing substance, a layer of the same substance is placed over the fissile material, and the charge within the die is subjected to pressure in the direction of the axis of the fuel element at the sintering temperature of the protective substance.

23107 NEUTRONIC REACTOR SHIELDING. L. B. Borst (to U. S. Atomic Energy Commission). U. S. Patent 2,992,175. July 11, 1961.

A special hydrogenous concrete shielding for reactors is described. In addition to Portland cement and water, the concrete essentially comprises 30 to 60% by weight barytes aggregate for enhanced attenuation of fast neutrons. The biological shields of AEC's Oak Ridge Graphite Reactor and Materials Testing Reactor are particular embodiments.

23108 HIGH STRENGTH CONTROL RODS FOR NEUTRONIC REACTORS. B. Lustman, E. F. Losco, and I. Cohen (to U. S. Atomic Energy Commission). U. S. Patent 2,992,178. July 11, 1961.

Nuclear reactor control rods comprised of highly compressed and sintered finely divided metal alloy particles and fine metal oxide particles substantially uniformly distributed therethrough are described. The metal alloy consists essentially of silver, indium, cadmium, tin, and aluminum, the amount of each being present in certain percentages by weight. The oxide particles are metal oxides of the metal alloy composition, the amount of oxygen being present in certain percentages by weight and all the oxygen present being substantially in the form of metal oxide. This control rod is characterized by its high strength and resistance to creep at elevated temperatures.

23109 FUEL ELEMENT FOR NUCLEAR REACTORS. C. H. Bassett (to U. S. Atomic Energy Commission). U. S. Patent 2,992,179. July 11, 1961.

Nuclear reactor fuel elements of the type in which the fissionable material is in ceramic form, such as uranium dioxide, are described. The fuel element is comprised of elongated inner and outer concentric spaced tubular members providing an annular space therebetween for receiving the fissionable material, the annular space being closed at both ends and the inner tube being open at both ends. The fuel is in the form of compressed pellets of ceramic fissionable material having the configuration of split bushings formed with wedge surfaces and arranged in seriated inner and outer concentric groups which are urged against the respective tubes in response to relative axial movement of the pellets in the direction toward each other. The pairs of pellets are axially urged together by a resilient means also enclosed within the annulus. This arrangement permits relative axial displacement of the pellets during use at high temperatures thereby substantially eliminating radial stresses on the inner and outer tube members and yet

maintains the fuel pellets in good thermal conductive relationship therewith.

23110 REACTOR. Robert F. Christy (to U. S. Atomic Energy Commission). U. S. Patent 2,993,852. July 25, 1961.

A means is described for co-relating the essential physical requirements of a fission chain reaction in order that practical, compact, and easily controllable reactors can be built. These objects are obtained by employing a composition of fissionable isotope and moderator in fluid form in which the amount of fissionable isotope present governs the reaction. The size of the reactor is no longer a critical factor, the new criterion being the concentration of the fissionable isotope.

Power Reactors

23111 (59GL140) SUMMARY OF T-7 REACTOR CONTINUOUS HYDRAULIC ROD DRIVE STUDY. W. A. Boothe (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Aug. 19, 1959. For General Electric Co. Atomic Power Equipment Dept. Contract AT(04-3)-189. 101p.

A summary is given of work performed in determining the feasibility of a control valve-position sensor configuration for maintaining a closed-loop control of the locking-piston actuator adapted to the reactor control rod. The results are discussed in terms of studies on the position sensor, servo valve, system dynamics, and ship's motion compensation. (B.O.G.)

23112 (59GL142) COMPUTER AND SYSTEM STUDY; T-7 REACTOR CONTINUOUS HYDRAULIC ROD DRIVE STUDY. David W. Leiby (General Electric Co. General Engineering Lab., Schenectady, N. Y.). July 10, 1959. For General Electric Co. Atomic Power Equipment Dept. Contract AT-(04-3)-189. 199p.

A description is given of the control rod system configuration from which a series of equations is written defining its modes of operation. From the equations and the numerical data given for the system, an analog simulation is constructed. A series of analyses is made of the open-loop performance of the valve-piston configuration for conditions of original parameter data and as a repeat of the same type of study for revised data, received later during the study. The results are in the form of curves of piston velocity as a function of control valve position. Following the open loop study of the system, a closed-loop-position system-operation investigation was made for the nominal values of the system parameters with variations in loop gain and ship's motion being investigated. The results were obtained in the form of 8-channel recorder charts. A discussion of the results and conclusions to be drawn from the information obtained in the open-loop and closed-loop performance investigation of the system are presented. (auth)

23113 (59GL143) SERVO VALVE STUDY; T-7 REACTOR CONTINUOUS HYDRAULIC ROD DRIVE STUDY. W. A. Boothe (General Electric Co. General Engineering Lab., Schenectady, N. Y.). July 17, 1959. For General Electric Co. Atomic Power Equipment Dept. Contract AT-(04-3)-189. 99p.

The study was concentrated on two- and four-way servo valves after a brief investigation of alternate schemes. The results of the study are discussed in terms of specified system design objectives, basic design considerations, approaches to servo-valve design, and vendor proposals. Appendices include a bibliography, calculations for two-

and four-way valves, and specifications for four-way valves. (B.O.G.)

23114 (59GL242) CONTROL SYSTEM STUDY FOR A 7 TANKER BOILING WATER REACTOR NUCLEAR PULSION SYSTEM. David W. Leiby (General Electric Co., General Engineering Lab., Schenectady, N. Y.). Nov. 2, 1959. General Electric Co. Atomic Power Equipment Dept. Contract AT-(04-3)-189. 250p.

The evaluation of the dynamic performance of the power plant under consideration is made utilizing analog computer techniques. The power plant and its controls are simulated, making various simplifying assumptions to produce a practical model which can be simulated on the existing facility. The model is scaled in real time and sinusoidal variations in ship's motion, acceleration, and changes in the steam load demands are applied as the primary driving functions. The results are obtained in the form of strip-chart recordings of important system variables. From the various recorder runs, families of curves are drawn showing trends and forms of variation of certain parameters of transient behavior as the function of system parameters or ambient conditions. From the results and interpretations, conclusions are drawn concerning the expected behavior of the power plant under the assumed operating conditions and control rod schemes. (auth)

23115 (AGN-TM-390) THE ARMY GAS COOLED REACTOR SYSTEMS PROGRAM. A PRELIMINARY STUDY OF A 1000 KW(e) MOBILE NUCLEAR POWER SYSTEM. Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 1960. Contract AT(19-1)-880. 75p.

The conceptual design of a 1000-kw(e) dual cycle, mobile nuclear power system is presented. The plant consists of a sodium-cooled reactor primary loop coupled to an open cycle air turbine power conversion system. The plant will operate for extended periods in an emergency, with air in a primary loop, but the net output is reduced to 800 kw(e). Increased plant flexibility is achieved by including a fossil fuel combustion chamber in parallel with the reactor, thus permitting full power plant operation with conventional fuels. The nuclear reactor in the system basically is an ML-1 modified to permit operation at higher pressures, temperatures, and power level. The plant consists of five packages, including the control cab and auxiliaries skid. The total plant weight is 98,000 lb, giving a specific weight of 98 /kw. (auth)

23116 (ANL-6374) REACTOR DEVELOPMENT PROGRAM, PROGRESS REPORT, MAY 1961. (Argonne National Lab., Ill.). June 15, 1961. Contract W-31-109-eng-61p.

General research and development on water-cooled and sodium-cooled reactors are reported along with specific developments on EBWR, BORAX-V, EBR-I, and EBR-II. Thermal and fast reactor safety studies are summarized in terms of fuel-coolant chemical reactions, kinetics of oxidation and ignition of reactor materials, core meltdown studies, and a sodium vapor pressure furnace. Evaluations are made of improved fast reactors for central station power and of a 50-Mwe Prototype Organic Power Reactor (OPR). Developments in instruments, reactor fuels and materials, reactor components, heat engineering, separations processes, and advanced reactors are discussed. (C.G.)

23117 (CF-61-3-9(App.)) THORIUM BREEDER REACTOR EVALUATION. PART I. FUEL YIELD AND FUEL CYCLE COSTS IN FIVE THERMAL BREEDERS. APPENDICES. L. G. Alexander, W. L. Carter, R. H. Chapman,

B. W. Kinyon, J. W. Miller, and R. Van Winkle (Oak Ridge National Lab., Tenn.). May 24, 1961. 206p.

The performances of aqueous-homogeneous (AHBR), molten-salt (MSBR), liquid-bismuth (LBRR), gas-cooled graphite-moderated (GCBR), and deuterium-moderated gas-cooled (DGBR) breeder reactors were evaluated in respect to fuel yield, fuel cycle costs, and development status. A net electrical plant capability of 1000 Mwe was selected with continuous processing of fuel and fertile streams. The maximum annual fuel yields were 16, 7, 4, 4, and 4.5%/yr, respectively at a fuel cycle cost of 1.5 mills/kwhr. The minimum estimated fuel cycle costs were 0.9, 0.6, 1.0, 1.2, and 1.3 mills/kwhr at fuel yields of 7, 1, 1, 2, and 3%/yr. At a fuel yield of 4%/yr, the costs were 0.9, 0.9, 1.5, 1.5, and 1.3 mills/kwhr. Only the AHBR and the MSBR are capable of achieving fuel yields substantially in excess of 4%/yr, and therefore only these two can be listed with confidence as being able to satisfy the main criterion of the AEC long-range thorium breeder program i.e., a doubling time of 25 years or less. The development effort required to bring the various concepts to the stage where a prototype station could be designed was estimated to be least for the AHBR, somewhat more for the MSBR, and several times as much for the other systems. The AHBR was judged to rank first in regard to nuclear capability, fuel cycle potential, and status of development. (auth)

23118 (DP-605) HEAVY WATER MODERATED POWER REACTORS. Progress Report, March 1961. R. R. Hood and L. Isakoff, comps. (Du Pont de Nemours (E. I.) & Co. Explosives Dept., Wilmington, Del.). May 1961. Contract AT(07-2)-1. 65p.

Construction of the Heavy Water Components Test Reactor (HWCTR) was about 65% complete at the end of March 1961. The results of two-dimensional calculations of neutron-flux distributions in the reactor indicate that the maximum-to-average flux ratios can be maintained at lower values than were anticipated previously. If the calculations are verified by operating experience, a 10 to 20% increase in permissible reactor power may be achievable. Measured values of the nuclear parameters of a lattice of massive uranium elements in heavy water differ appreciably from calculated values. However, the differences partially compensate for one another so that the corresponding infinite multiplication constants for the lattice differ by only 4%. Fission gases in irradiated fuel elements of compacted, fused uranium oxide in Zircaloy sheaths constituted only a minor fraction of the total gas released by the elements when the sheaths were punctured. It is concluded from this finding that the pressure exerted by the fission gases during irradiation was not a factor in the irradiation failures of the elements. A new evaluation is presented of the economic potential of power reactors that are moderated and cooled by heavy water and fueled with natural uranium. (auth)

23119 (DPR/INF/261) BRITISH EXPERIENCE IN THE TECHNICAL DEVELOPMENT OF NUCLEAR POWER REACTORS. John Cockcroft (United Kingdom Atomic Energy Authority, London). May 1961. 10p.

British experience in the development of nuclear power was gained chiefly through the development, construction, and operation of nuclear power stations using the gas cooled graphite moderated reactor as a source of heat for producing steam. The Calder Hall reactors, fuel element development, nuclear characteristics of reactors, reactor stability, graphite behavior, production of radioisotopes, development of the power program, the Advanced Gas Cooled Reactor, the High Temperature Gas Cooled Reactor, the Fast Breeder

Reactor, spent fuel processing, and effluent disposal are discussed. (M.C.G.)

23120 (GEAP-3627) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH DEVELOPMENT PROGRAM. Second Quarterly Report, October 1960–December 1960. W. H. Cook (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Project Agreement No. 11. Contract AT(04-3)-189. 49p.

Goals reached in the testing of advanced fuel power limits included the following: (1) the design of the instrumented assemblies was completed; (2) the rod oscillator mechanism was completed; (3) the evaluation of mathematical models of power-reactor stability was begun; (4) twenty-five Fuel Cycle fuel assemblies were irradiated at power levels to 15 Mw(t); (5) the plan for the special fuel program was completed; and (6) the fabrication of center-melting calibration fuel assemblies was started. Out-of-pile measurements in critical areas of heat transfer and fluid flow included (1) data on a single-rod fuel assembly test section, (2) the developing and refining of techniques for observational testing in boiling experiments, and (3) the conclusion of single- and two-phase pressure-drop measurements on a prototype Fuel Cycle fuel element. (For preceding period see GEAP-3558.) (B.O.G.)

23121 (GEAP-3717) HIGH POWER DENSITY DEVELOPMENT PROJECT, FOURTH QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1961. L. K. Holland (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 1, 1961. Contract AT(04-3)-361. 91p.

High-Power Density Fuel Development. High-power density VBWR fuel assemblies were irradiated to ~400 Mw(t) and found to be in good condition after irradiation. Fabrication and calibration of two instrumented VBWR fuel assemblies are described. Fuel Fabrication Development. A tandem-rolled fuel bundle was produced. Swaging studies were carried out for stainless steel-clad fuel rods. Inspection of defected clad powder-compacted UO_2 specimens after 570 hr of erosion flow testing in water or steam at 535 to 545°F indicated that only small amounts of UO_2 had been eroded. A study of density-particle size relationships was made for vibratory-compacted binary and ternary fused UO_2 powder mixes. Design characteristics are given for 10 special HPD-VBWR assemblies. Vibration tests on a 36-rod Consumers-type element are reported. Stability, Heat Transfer, and Fluid Flow. The results of a stability analysis of the 50-Mw Big Rock Reactor are presented. Physics Development. The effects of enrichment variations in the fuel rods and of inserted control rods on the power distribution were studied. Studies of gross radial power distribution for a 300-Mw reactor indicate that proper radial cycling of partially burned fuel can produce desirable radial power shapes. The physics analysis of the reactor core for a large 300-Mwe conceptual design is summarized. The incentives and functions of a computer to be used for maximizing fuel burnup are discussed. (D.L.C.)

23122 (HRP-177) OEEC HALDEN REACTOR PROJECT, EIGHTH QUARTERLY PROGRESS REPORT, COVERING PERIOD APRIL 1, 1960–JUNE 30, 1960. (Norway. Institutt for Atomenergi. OEEC Halden Reaktor Prosjekt). 16p.

The preparatory and modification work necessary to bring the Halden Power Reactor to power on the first fuel charge was continued. The IFA safety organization was reconstituted and a new mode of operation was initiated. A discussion is given of reactor physics studies made during the period. A new model of the core hydrodynamics for the computer was developed. In-core instrumentation work

was devoted mainly to the development of measuring techniques. Engineering work included: repair of first-charge fuel elements; fuel element seals; primary and secondary coolant systems; instrumentation; second fuel charge; new control stations; shielding and handling equipment; and civil engineering studies of the gas-tightness of the rock around the airlock, and of the escape possibilities through the airlocks in emergencies. Radiation protection measures taken during the period are discussed. (B.O.G.)

23123 (JPL-TR-32-94) GASEOUS FISSION REACTOR FOR BOOSTER PROPULSION. Robert V. Meghreblian (California Inst. of Tech., Pasadena. Jet Propulsion Lab. Mar. 31, 1961. Contract No. NASw-6. 18p.

The gaseous fission reactor concept was examined as the prime energy source for the direct heating of the propellant in a high-thrust rocket engine. The analysis reveals that, regenerative cooling is the only mechanism for removing the radiation heat deposited in the solid members of the reactor and engine, then there is a maximum attainable specific impulse of about 3 times that for the corresponding all-solid-fuel reactor. In the high-thrust application the thermal radiation from the fissioning gas is not a critical factor. Even with conservative estimates of gas emissivities, the resulting engine performance is markedly superior to other methods of propulsion. Typical engine and vehicle characteristics were determined for a variety of mission ranging from 25,000 to 60,000 ft per sec velocity increments. (auth)

23124 (NAA-SR-Memo-5979) HNPf SODIUM SYSTEM–STATIC AND DYNAMIC PERFORMANCE. R. E. Fortier (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 8, 1961. 17p.

Results of an analog study of the Hallam Nuclear Power Facility sodium flow control system are presented. Recommended field adjustments for the control system components are also included. (J.R.D.)

23125 (NAA-SR-Memo-5980) HNPf SODIUM SYSTEM IHX FREQUENCY RESPONSE. R. E. Fortier (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 27, 1961. 23p.

Frequency response characteristics of an analog model of the Hallam Nuclear Power Facility sodium system are presented. The system consists of the IHX, primary and secondary sodium hydraulics plus associated flow and temperature control subsystems. Correlations of the IHX heat parameter system frequency response is reasonable at low frequencies, but differs markedly in the high frequency spectrum. The responses of secondary outlet temperature to output signals at maximum and minimum power levels are also included. (J.R.D.)

23126 (NMI-7239) POWER REACTOR PROGRAM. Progress Report to Savannah River Operations Office, United States Atomic Energy Commission, April 1, 1961–April 30, 1961. S. Isserow, R. W. Anderson, W. J. Richmond, E. F. Jordan, A. R. Gilman, and W. B. Tuffin (Nuclear Metals, Inc., Concord, Mass.). May 24, 1961. Contract AT(30-1)-1565. 16p.

The status of the program for developing components for heavy water moderated reactors is reported. Extrusion of 5 Cu–Ni tubes led to the adoption of a modified lubrication procedure, standardization of tool temperatures at 700°F and redesign of the front of the billets for outer tubes. The use of a floating mandrel in two of the extrusions gave no beneficial results. A program for studying the effect of restraining pressures on the irradiation-induced swelling of uranium fuel tubes was initiated. A measurement of the radial G_2 growth index was obtained on the transient zone

luted uranium tube. The second G_2 value, -0.28 , was in good agreement with the previous value of -0.32 . Evaluation of four extruded stainless steel-Zircaloy tubular joints shows that the joints can be successfully cold-reduced 40% by the Tube Reducing Process. (D.L.C.)

127 (NP-10296) OEEC HALDEN BOILING HEAVY WATER REACTOR PROJECT SECOND ANNUAL REPORT. Norway. Institutt for Atomenergi. OEEC Halden Reaktor (Projekt). Apr. 1961. 163p.

Published by Organization for European Economic Cooperation, Paris.

The second annual report of the Halden Boiling Reactor is presented. Among the items discussed are reactor design, fuel charges, operation, safety, and research program. (L.C.)

128 (ORNL-3102) GAS-COOLED REACTOR PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING MARCH 31, 1961. (Oak Ridge National Lab., Tenn.). May 26, 1961. Contract W-7405-eng-26.

Reactor Physics. Criticality calculations were made for the EGCR without experimental loops and for various enrichments, and the results were used to derive the base value for the EGCR fuel enrichment. Reactor Design Studies. Studies of the performance of EGCR fuel and control rods were made. The moderator temperature distribution and the required coolant flow were determined. Investigations of structural integrity were made for the EGCR pressure vessel, through-tubes, and graphite column. The results of a preliminary study of the EGCR containment system and of the possibility of a runaway graphite fire are discussed. Decontamination studies of EGCR components are reported. Heat Transfer and Fluid Flow. Studies of fluid flow asymmetries, surface-temperature profiles, and heat transfer coefficients are reported. The application of mass transfer measurements to predictions of heat transfer in seven-tube clusters is concluded to be valid. Velocity contours were mapped for EGCR channels. Pressure-drop and gas-mixing measurements in EGCR fuel assemblies are reported. Materials Development. Fabrication of dense UO_2 grains and discs is described. Measurements of ^{135}Xe release rates from UO_2 pellets and powders at 400 to 1000°C are reported. Fabrication studies were carried out with BeO. The phases present in $BeO-ThO_2-UO_2$ systems were identified to be pure BeO, a ThO_2-UO_2 solid solution, and a small amount of pure UO_2 . Evaluation of UO_2 spheres coated with pyrolytic carbon by thermal cycling and leaching tests is reported. Evidence of a reaction between UC and Be was found after a 66-hr test at 1100°C. Inspection results are presented for coatings on EGCR graphite support sleeves. Measurements of the mechanical properties of AGOT graphite are reported. Axial elongation of EGCR fuel elements in thermal cycling experiments was studied. Oxidation and carburization of 304 stainless steel CO-CO₂ mixtures were studied. The thermal stability of Sb_2O_3 was studied at 400 to 1000°C. Oxidation of Be by CO_2 and H_2O vapor was studied. Studies on joining Be clad fabrication of Be-clad fuel elements were made. In-pile Testing. Irradiations of a large number of fuel specimens and structural materials were carried out and the results of postirradiation examinations and property measurements presented. Out-of-pile Testing. Static and convection loop tests in hot helium were carried out with graphite and metal specimens, and carburization reactions in these systems were studied. The degassing behavior of graphite was studied, and porosity determinations are reported. The results of investigations of the removal of fission gases from He and other gases are discussed. Abnor-

mal emf drifts of thermocouples in He are discussed.

Development of Test Loops and Components. Testing and development of the following components are discussed: EGCR through-tube nozzles, microswitch, globe valves, GCR-ORR loop No. 2, and loop compressors. (D.L.C.)

23129 (ORO-413) SMALL PRESSURIZED WATER REACTOR; DAIRYLAND POWER COOPERATIVE SITE REPORT. (Gibbs and Hill, Inc., New York). July 18, 1960. 26p.

A site for a small PWR near LaCrosse, Wis. is examined. The site is described and information on geology, hydrology, meteorology and seismology of the surrounding area is included. (J.R.D.)

23130 (SRO-49) HEAVY WATER POWER REACTOR PROGRAM. Monthly Progress Report [for] May 1961. (Savannah River Operations Office, AEC). 17p.

Research and development activities are summarized for AEC/AECL co-operative program, and heavy-water power reactor studies by du Pont, Columbia University, Nuclear Metals Inc., Nuclear Development Corp., and Sargent & Lundy. Design, construction, and costs are reviewed for the Heavy Water Components Test Reactor. Developments are discussed for the Florida Power Reactor and the Carolinas-Virginia Tube Reactor. (B.O.G.)

23131 (WAPD-PWR-TE-67(Del.)) PURIFICATION SYSTEM PERFORMANCE DURING PWR-1 SEED 1 DEPLETION. W. Lechnick and K. H. Vogel (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 21, 1960. 18p.

An evaluation was made of purification system performance during PWR-1 Seed 1 depletion. The reactor system was operated with full flow through the 1AC and 1BD Purification Systems for the first 2900 EFPH of plant life. During this period data were taken on radiation levels from the primary system components, crud levels in the primary coolant, crud specific activity, fission product levels in the primary coolant, activity buildup on the hairpin loop, and control chemistry. The 1BD Purification Loop was then secured and the plant operated for 2000 EFPH with full flow through the 1AC Purification Loop only. With the plant operating under these conditions, data were taken as before to determine if there was a change in trend for long-lived activity buildup. It was found that the trend for long-lived activity buildup in primary system piping and associated components during the half purification run did not differ significantly from that observed during full purification operation. Gross degassed gamma activity levels of the primary coolant increased by a small degree during the half purification run. Long-lived iodine activity levels increased by a factor of two. Half purification appeared to be as efficient as full purification in maintaining low crud levels in the primary coolant. The specific activity for Co^{60} in primary coolant filtrate and crud specific activity were unaffected by the test. There were no adverse effects on activity buildup in the primary system as determined by the Hairpin Loop analysis. (M.C.G.)

23132 (WAPD-PWR-TE-102) DETERMINATION OF REACTOR COOLANT SYSTEM PRESSURE DROP (TEST EVALUATION). Lawrence H. Kemmet (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 10, 1961. Contract [AT-(11-1)-GEN-14]. 38p.

The fifth determination of the PWR coolant system pressure drop and flow characteristics was performed prior to the initial Seed 2 approach to power. Coolant loop flowrate and pressure drop data were taken with the reactor subcritical and the primary plant pressure and coolant temper-

ature maintained at a nominal 1770 psia and 500°F, respectively. The main coolant pumps were operated on both fast and slow speed with four loops in operation and with four combinations of three loops in operation. (auth)

23133 (WCAP-4055) CVTR PROJECT. CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. MONTHLY PROGRESS REPORT, MAY 1961. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Contract AT(30-1)-2289. 27p.

The capsule A-2 was removed from the WTR reflector hole at the end of the WTR Cycle 13, and was stored in the WTR canal. The in-pile loop has operated for eight months and the test thimble was irradiated a total of 108 days. Tensile tests were completed on the extruded and annealed Zircaloy-4 Phase-II pressure tubes. The tensile properties varied with location in the pressure tube. The lowest values were obtained in the top flange where the material was fully annealed for ten hours at 800°C. Increased properties were achieved from working the material during extrusion operations. A shielding ring is provided to prevent streaming through a void generated by the rotating shield volley supports. It was determined that an additional thickness of iron or steel is required to compensate for the loss of shielding from the removal of one foot of concrete at the bottom of the trench. Various portions of the U-tube and fuel assemblies were homogenized in various axial regions for computer studies. The studies indicated a decrease of 500 hours in core life from non-uniform axial burnup. Pressure tube specimens are being tested under the impulsive test burst program. A test specimen experienced a 51% increase in O.D. under 20 impact blows before it failed. Observations of the tested specimens indicated ductilities far in excess of those predicted from the material's behavior in uniaxial tension. Tests on a Zircaloy-stainless steel joint were concluded after an extensive program of testing under various pressure, temperature and bending moment conditions. No sign of leakage was noted throughout the program. Subsequent inspection of the joint showed cracks in the sleeve portion of the joint. Analysis of the test water indicated a chloride content of approx 88 ppm. A test fuel assembly was dismantled and converted to a four baffle design. Modifications were made to the prototype control-rod-drive system. The alignment between the vertical and horizontal miter gears was improved by changing the mounting of horizontal shaft and bearings. Scram tests were resumed; these tests indicated that the dashpot was acting too soon. The dashpot is being modified. (auth)

23134 (YAEC-183) A STUDY OF FUEL DEPLETION AND CONTROL ROD PROGRAMMING IN THE YANKEE REACTOR. J. D. McGaugh (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Nov. 1960. 61p. For Yankee Atomic Electric Co., Boston, Contract AT(30-3)-222, Subcontract No. 1. 61p.

A study was made of the effects of fuel depletion and control rod programming on the power density distribution in the Yankee reactor. Values of the nuclear hot channel factors, F_Q and F_{AT} , were calculated at various stages of fuel burnup and estimates of control rod worth and core life-time were made. (auth)

23135 ON THE CHOICE OF OPTIMUM STEAM CONDITIONS OF THE THERMAL CYCLE IN NUCLEAR POWER STATIONS. D. Grecov. *Rev. electrotech. energet., Acad. rep. populaire Roumaine*, 5: 409-35(1960). (In English)

An analysis is made of the optimum thermal cycle for a power reactor, and suggestions are offered conducive to more efficient and economical thermal cycle selection. (R.V.J.)

23136 NUCLEAR HEATING POWER STATIONS WITH GAS TURBINES FOR VARIOUS OPERATING MEDIA.

K. Bammert (Technische Hochschule, Hanover). *Atomkernenergie*, 6: 185-99(May 1961). (In German)

The question as to how power stations using helium, nitrogen, and carbon dioxide as working media have to be rated to ensure the highest possible economy is considered. The efficiency of the turbine is largely dependent on the expansion ratio. Any variation thereof leads to a variation not only of the efficiency and the useful quantity of exhaust heat but also of the size and thus the cost of all plant components. An important factor for determining the cost of the coolers is, apart from the expansion ratio, the actual consumption of the useful heat. The dependence of the size of the plant components on these two factors is examined and at the same time the highest possible receipts from power and heat supplies ascertained. Thereby it becomes apparent that for each rating of the coolers there is a particular expansion ratio ensuring the highest proceeds. However, this is not a solution to the problem of finding the most favorable layout. This can be found only by comparing the proceeds and the investment cost to each other. The result is an optimum both for the expansion ratio and the corresponding cooler size, which depends on conditions such as the yearly working time, amortization and interest payments. (auth)

23137 THERMAL PROBLEMS OF GAS COOLED REACTORS. [PART] I. H. Benzler (Deutsche Babcock & Wilcox Dampfkesselwerke A. G., Oberhausen/Rheinland, Ger.). *Atompraxis*, 7: 135-41(Apr. 1961). (In German)

Thermal problems of gas cooled reactors, list of symbols, shape of cooling channels and fuel, influence of cooling gas, and pressure and coolant-optimization are discussed. (auth)

23138 BULLETIN OF NO. 7. NUCLEAR INSTRUMENTATION. *Bull. inform. sci. et tech.* (Paris), No. 50, 35-63(Apr. 1961). (In French)

The $\frac{1}{20}$ th scale model of the G-2 Reactor is described in some detail, and information is given on the present studies and instrument development at the Commissariat à l'Energie Atomique. Detectors, counting and selector apparatus, personnel monitoring devices, amplifiers, prospecting apparatus, and measurement devices are discussed. (J.S.R.)

23139 CHIMNEY SWEEPING INSTALLATION OF THE CHINON EDF-1 and EDF-2 POWER STATIONS. G. Fritz (Société Siersatom, Paris). *Inds. atomiques*, 5: No. 3-4, 135-6(1961). (In French)

The remote-control apparatus designed to remove bars, debris, and dusts accidentally present in the lower part of the EDF-1 and EDF-2 Reactors is described. (J.S.R.)

23140 THERMAL CYCLE OF NUCLEAR POWER STATIONS WITH GAS COOLED REACTOR. PART III. Jan Jüza (Lenin Factory, Plzen, Czechoslovakia). *Jaderná energie*, 7: 117-121(Apr. 1961). (In Czech)

The calculation and analysis of thermal cycle optimum parameters for nuclear power stations using gas for cooling in the primary cycle and steam in the secondary cycle are reported. The steam superheater uses conventional fuel. (auth)

23141 THERMIONIC REACTOR SYSTEMS. R. C. Howard (General Atomic Div., General Dynamics Corp., San Diego, Calif.). *Nuclear Sci. and Eng.*, 10: 173-82(June 1961).

The possible concepts for utilizing thermionic cells with nuclear reactors are reviewed, and the feasibility of their applications is discussed. (auth)

142 LOCATING FAILED FUEL IN WATER REACTORS. Robert N. Osborne (General Electric Co., San Antonio, Calif.). *Nucleonics*, 19: No. 7, 84; 86; 89 (July 1961).

A technique is described by which failed fuel elements in water cooled reactors may be located by detection of I^{132} activity increases. The I^{132} is produced by the decay of 77 or Te^{132} . The method is used during reactor shutdown. The fuel channel in question is sealed off from the main plant flow to reduce background counting, and air or water is circulated through the channel and monitored. (F.H.)

143 COMMENTS ON SOME ASPECTS OF NUCLEAR POWER ECONOMICS. L. E. Crean, R. A. Laubenstein, and S. Mims (International Atomic Energy Agency, Vienna). *ibid.* 63p. (STI/Pub/15/9)

The main factors affecting the economic use of nuclear power plants for the supply of the world's expanding energy requirements are discussed. A general survey is given of sources of hydrocarbon, carbon, and radioactive fuels and local factors which have an influence on nuclear power programs. The technical and economic factors affecting the choice of either the enriched-uranium or the natural-uranium system are outlined and relative advantages and disadvantages explained. Selection of a specific reactor type for development necessitates consideration of the technical aspects of present reactor designs, e.g., the enriched-uranium thermal reactor, breeder reactor, and natural-uranium and plutonium-recycle reactor. Technical factors involved include current and projected cost of power, the current status of technical development, and additional development costs required to obtain economical nuclear power; economic factors are related to capital costs, fuel-cycle costs, heavy-water inventory where required, and the costs of operation and maintenance. (auth)

144 NEUTRONIC REACTOR CORE. Wallace B. Thomson and Austin Corbin, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 2,992,981. July 18, 1961. An improved core for a gas-cooled power reactor which admits gas coolant at high temperatures while affording strong integral supporting structure and efficient moderation of neutrons is described. The multiplicities of fuel elements constituting the critical mass of fissionable material are supported and confined by a matrix of metallic structure which is interspersed therebetween. Thermal insulation is interposed between substantially all of the metallic matrix and the fuel elements; the insulation then defines the principal conduit system for conducting the coolant in heat-transfer relationship with the fuel elements. The metallic matrix itself comprises a system of ducts through which an externally-cooled hydrogenuous liquid, such as water, is circulated to serve as the principal neutron moderator for the core and conjointly as the principal coolant for the insulated metallic structure. In this way, use of substantially neutron transparent metals, such as aluminum, becomes possible for the supporting structure, despite the high temperatures of the proximate gas. The aircraft Nuclear Propulsion program's "R-1" reactor design is a preferred embodiment.

145 COUPLED FAST-THERMAL POWER BREEDER REACTOR. Robert Avery (to U. S. Atomic Energy Commission). U. S. Patent 2,992,982. July 18, 1961.

A nuclear reactor having a region operating predominantly on fast neutrons and another region operating predominantly on slow neutrons is described. The fast region has a plutonium core and the slow region is a natural uranium

blanket around the core. Both of these regions are free of moderator. A moderating reflector surrounds the uranium blanket. The moderating material and thickness of the reflector are selected so that fissions in the uranium blanket make a substantial contribution to the reactivity of the reactor.

Production Reactors

23146 FAST NEUTRON REACTOR. Harry Soodak and Eugene P. Wigner (to U. S. Atomic Energy Commission). U. S. Patent 2,993,850. July 25, 1961.

A reactor comprising fissionable material in concentration sufficiently high so that the average neutron energy within the reactor is at least 25,000 ev is described. A natural uranium blanket surrounds the reactor, and a moderating reflector surrounds the blanket. The blanket is thick enough to substantially eliminate flow of neutrons from the reflector.

Research Reactors

23147 (AD-249048) CRITICAL EXPERIMENT REACTOR GAMMA-RAY LEAKAGE STUDIES FOR RER OPERATION. R. J. Cashwell (Lockheed Nuclear Products, Marietta, Ga.). Dec. 1960. Contract AF33(600)-38947. 34p. (NR-113)

Measurements made on several cores in the CER indicated that the fuel-voided-center core gave substantially increased gamma leakage flux. The core was fully investigated and checked out in the RER. (auth)

23148 (JEN-83-DF/I-25) MEDIDA DE FLUJOS DE NEUTRONES EN EL NUCLEO DEL REACTOR JEN-1. (Determination of Neutron Flux in Reactor JEN-1). L. Manas Diaz and J. Montes Ponce de Leon (Spain. Junta de Energia Nuclear, Madrid). 1960. 16p.

A summary is given of irradiations that were made to determine the neutron flux distributions in the core of the JEN-1 reactor. Gold foils of 380 μ g and Mn-Ni (12% of Ni) of 30 mg were employed. The epithermal flux was determined by the Cd ratio. The resonance integral values given by Macklin and Pomerance were used. (auth)

23149 (NARF-61-15T) TEST ANALYSIS OF THE 3-Mw GROUND TEST REACTOR. W. Park (Convair, Fort Worth, Tex.). May 31, 1961. Contract AF 33(600) 38946. 80p. (MR-N-254)

The instrumentation and reactor frame of the Ground Test Reactor at Convair-Fort Worth were modified in order to increase the power level from 500 kw to 3 Mw. A criticality experiment was performed, and the control rods and power-level instrumentation were calibrated. Performance studies were made of the heat-transfer system, control-rod magnets, bypass panel, and the power-level controller. Activation and poison buildup were analyzed. (auth)

23150 (NP-10299) DOSIMETRY MEASUREMENTS OF THE GENERAL ATOMIC TRIGA MARK F REACTOR (DOFL PROTOTYPE). Report No. S-38. G. Leidenheimer, W. Quam, C. Leek, and H. Borella (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). May 5, 1961. Contract DA-49-186-502-ORD-931. 90p.

Descriptions are given of the reactor, measurement area, detector system, and experimental measurements. The flux data given are based on 2.0 barns for the fast cross section for Pu^{239} and on activation flux for thermal

calibrations using the most probable neutron velocity of 2200 m/sec. Modifications of the data are appended to conform to measurements made previously. (B.O.G.)

23151 (REIC-16) SURVEY OF IRRADIATION FACILITIES. Mary Jane Oestmann (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Feb. 28, 1961. Contract AF33(616)-7375. 218p.

A survey is presented of irradiation facilities generally available to the Air Force and its contractors. Reactors operated at steady-state and pulsed conditions, and gamma facilities were included in the survey. This report supersedes REIC Reports 7, 7 (First Addendum) and 11. (auth)

23152 (TID-12605) HEAVY WATER COMPONENTS TEST REACTOR. (DuPont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). June 1, 1961. 13p.

An outline is given of the construction status and design characteristics of the Heavy Water Components Test Reactor. (B.O.G.)

23153 ASTRA-FUEL ELEMENTS. H. Bildstein and P. Koss (Österreichische Studiengesellschaft für Atomenergie GmbH, Vienna). Atompraxis, 7: 126-8 (Apr. 1961). (In German)

The fuel elements of the research reactor ASTRA of the Österreichische Studiengesellschaft für Atomenergie GmbH are of the MTR type. A description of the construction principals of the fuel elements based upon the operating conditions of the reactor is given. (auth)

23154 THE BR-2 REACTOR AT THE CENTRE D'ETUDES DE L'ENERGIE NUCLEAIRE OF MOL (BELGIUM.) René Gobian. Rev. aluminium, No. 284, 208-19 (Feb. 1961). (In French)

The construction of the high flux reactor BR-2 is described in some detail with respect to fabrication and welding techniques used in the reactor vessel. Factors which influence the quality of the weld are tabulated. Fabrication control in the reactor vessel is discussed, and the arrangement of the experiment channels and the construction of the control mechanism are considered. (J.S.R.)

23155 THE PETTEN REACTOR OF THE REACTOR CENTRUM NEDERLAND. Maurice Victor. Rev. aluminium, No. 284, 220-2 (Feb. 1961). (In French)

A brief survey is given of the design and fabrication of the reactor vessel of the Petten Reactor. The welding procedure is described. (J.S.R.)

WASTE DISPOSAL AND PROCESSING

156 (CRCE-1004) THE VOLATILIZATION AND COLLECTION OF RUTHENIUM AND CESIUM IN A SYSTEM FOR INCORPORATING FISSION PRODUCTS INTO GLASS. R. Bancroft, L. C. Watson, and C. W. Hoelke (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 20, 1961. (AECL-1233).

During the incorporation of fission products into glass, about 50% of the ruthenium and 2% of the cesium was released as vapor from the mixes. It was not possible to reduce significantly the extent of Ru and Cs volatilization. It was possible to remove the isotopes efficiently from the gaseous off-gases to allow their reincorporation into glass. Laboratory tests indicated that a column packed with granules of siliceous firebrick coated with iron oxide was about 99% efficient for retaining Ru and better than 95% efficient for Cs. Bed temperatures near 600°C were best for a 200° spread on either side of this was acceptable. Changes in air velocity from 0.1 to 2 fps at 600° did not alter the efficiency. More than 90% of the elements released was collected on the inlet inch of the 4-in.- and 12-in.-deep beds. This distribution was favorable for the continuous or intermittent charging and discharging of a collector in a future plant. It was shown that the collector material could be melted into glass without reducing the quality of the glass. The operation of 12-in.-deep beds packed with firebrick/iron oxide granules to treat the off-gases from 100-curie batches of mixed fission products confirmed the efficient operation observed in the laboratory. The ability to clean the gases further by nitric acid scrubbing was demonstrated. (auth)

157 (HW-SA-1983) WASTE CONTROL AT THE HANFORD PLUTONIUM PRODUCTION PLANT. R. F. Oster, R. L. Junkins, C. E. Linderth (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.). Oct. 2, 1960. Contract AT(45-1)-1350. 40p.

The management of radioactive wastes at the Hanford Plutonium Production Plant is discussed. The varied processes and research operations which generate the radioactive wastes are indicated schematically. Wastes which result from fuel preparation, reactor operation, and chemical separations and the methods used for processing and disposal of them are described. The objectives of the waste disposal program are outlined. Methods of tracking released material and measuring radiation from environmental sources are also described. (M.C.G.)

158 REMOVAL OF RADIOCESIUM FROM WASTE WATERS BY PRECIPITATION WITH HEAVY METAL SALTS OF FERROCYANIDE. S. Krawczynski (Kernreaktor Bau- und Betriebs G. m. b. H., Karlsruhe, Ger.) and B. Kanella-Pulos. Atomkernenergie, 6: 214-17 (May 1961). (In German)

The extraction of Cs¹³⁷ from water by precipitation with Fe(III), Fe(II) and Ni(II) salts of ferrocyanide was examined as functions of precipitating agent concentration and of pH. One gathers from literature that cesium can be precipitated with the ferrocyanides of Zn, Ni, Cu, Fe(II), Pb, Cd, U(VI), and Mn(II) as well as with the ferrocyanides of Ni, Cu, and Zn. In this connection, the greatest effectiveness of Cs extraction is achieved by precipitation with ferrous and ferricyanide of Zn and with Ni and Fe(III) ferrocyanide. Whereas precipitation with nickel-ferrocyanide is

relatively non-sensitive to pH (pH 5 to 10), precipitation with zinc ferrocyanide results in the specifically thickest slime and thereby in the specifically highest Cs activity. Since the experimental results available in literature are incomplete, and also since the results published by other authors could not be reproduced in all respects, some systematic investigations were performed. The tests have shown that Cs can be precipitated quantitatively with ferrocyanides of Cu, Fe(II), Fe(III), and Ni. The success of Cs extraction depends to a great extent on the correct pH adjustment. Therefore, the pH adjustment must be performed with particular care in the case of decontamination of large quantities of waste water contaminated with Cs¹³⁷. Since most precipitation procedures for the decontamination of waste waters work best in the pH area 11, whereas the Cs precipitations described with ferrocyanides are best in a lower pH area, it is advisable for practical work to perform a two-step precipitation with two different pH values. The precipitation can be performed either discontinuously or continuously. (auth)

23159 CHEMICAL PROCESSES FOR THE DEACTIVATION OF EFFLUENT WATER. H. W. Levi (Hahn-Meitner-Institut für Kernforschung, Berlin). Atomwirtschaft, 6: 265-9 (May 1961). (In German)

The treatment of radioactive waste is especially concerned with effluent water of low activity which accumulates in large volumes. The installation and operating costs are important factors in the choice of suitable processes, particularly for small plants dealing with very variable activities and amounts. Precipitation advantages are compared with ion exchange and evaporation methods. (auth)

23160 THE REMOVAL OF CONTAMINATING NUCLIDES IN AQUEOUS SOLUTIONS WITH BENTONITE AND PRECIPITANTS. Hisateru Okuno and Hirofumi Arino (St. Paul's Univ., Tokyo). Radioisotopes (Tokyo), 9: 1-5 (Apr. 1960). (In Japanese)

The coagulating and precipitating power of the carbonates and chlorides of Ba, Ca, Mg, and of Al(OH)₃ were studied in order to get the bentonites in compact and easily filtered forms. Fairly good separations of bentonites from aqueous phases were obtained without any decrease of the decontaminating capacities of the bentonites. Whether coagulating salts were present or not, nearly the same efficiency for Ce¹⁴⁴ removal was obtained. (P.C.H.)

23161 RADIOACTIVE WASTES. THEIR TREATMENT AND DISPOSAL. J. C. Collins, ed. New York, John Wiley & Sons Inc., 1960. 256p. \$8.00.

The nature and hazards of radioactivity are reviewed. Fundamental problems encountered in handling radioactive materials and methods for the measurement of radioactivity are discussed. It is pointed out that radioactive wastes may be liquid, solid, or gaseous, but regardless of the form, disposal must be carried out so that there is no danger either to present or future generations. Legislation in Great Britain applicable to the disposal of radioactive wastes is reviewed. Methods are outlined for the treatment of radioactive liquid effluents, the disposal of radioactive solid wastes, and the discharge of radioactive effluent to the atmosphere. (C.H.)

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